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Periarthritis of the Shoulder

Walter M. Solomon, M. D.

Pain in the shoulder is one of the more frequent complaints and certainly a difficult one for which to make a correct diagnosis. Many conditions removed from the shoulder itself may have pain referred to this region and include such cardiac conditions as angina pectoris, coronary sclerosis, aneurysms of the aorta; or the pulmonary disorders as pleurisy, pneumonia, tuberculosis, carcinoma of the lung and others; or such lesions in the gastrointestinal tract as gastric and duodenal ulcers, diseases or stones in the gall bladder, various disorders of the liver, even appendicitis; then there is the characteristic pain from a particular type of pelvic inflammatory disease which can cause pain to be referred to the shoulder joint. Definite lesions of the shoulder joint itself and the adjoining structures are to be considered. The most important are fractures, dislocations and the sprains of the muscles and ligaments. Various types of infections involving the muscles and tendons are not infrequent. Neuritis due to diabetes, lead poisoning, avitaminosis, alcohol and other toxic agents also involve this area with symptoms and signs of disability. And not the least in importance is arthritis of the shoulder joint which may be caused by such specific organisms as the gonococcus, the tubercle bacillus, pneumococcus and others; and the two large groups of nonspecific arthritis—namely, atrophic and hypertrophic arthritis. However, in addition to these many diseases and disorders, there is periarthritis of the shoulder which is very painful and occurs frequently and for which physical therapy is indispensable. The word "periarthritis" means involvement of structures outside the joint itself. This disorder often is given a diagnosis of subdeltoid bursitis or subacromial bursitis which implies pathological changes in these individual bursae, but frequently the bursae are not the only structures involved. The term "periarthritis" appears to be sufficiently noncommital and still specific enough to cover the subject.

Periarthritis of the shoulder is extremely common. It has been estimated that 80 per cent of all cases of pain in this area is due to this condition.[1] During the past three years at Cleveland City Hospital there have been 147 such cases which is evidence of its frequency. Males and females are about equally affected. It occurs at all ages but with the greatest incidence between the ages of forty and fifty years. The right shoulder is involved more frequently than the left though it is not uncommon to be bilateral.

The cause for periarthritis is unknown. Many authorities believe it to be traumatic in origin. The trauma may appear to be insignificant when compared to the presenting symptoms. The patient may explain that the onset followed such an injury as throwing a ball or reaching to a top shelf. Often the patient will tell of a blow to the shoulder or of a fall either striking the shoulder or with the arm extended and the force of the fall transmitted to this joint. The trauma may be chronic as due to over-use of the arm in work or in certain forms of sport. It is not infrequent to have the patient relate that the symptoms started following an exposure to drafts at night or while driving in an open automobile.

Infection is considered by many to be the

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etiological factor. This infection may arise from a focus elsewhere in the body, as the teeth, tonsils, et cetera, and it is not infrequent for periarthritis to follow an acute upper respiratory infection or a flare-up of sinusitis. It may be that an infectious process may be present and the insult of slight trauma to the shoulder may be sufficient to initiate the disorder.

Metabolic disorders such as hyperthyroidism, hypothyroidism and diabetes have been stressed by Dickson.[2] In his series of 200 cases he found 32 patients with these accompanying conditions. The syndrome of menopause, in my opinion, very frequently is associated with this type of periarthritis. The rapid and satisfactory response to estrogenic substances in many female patients would argue for this as a possible causative or certainly an associated factor.

Definite changes take place in the various structures about the shoulder which vary in intensity and will differ whether in the acute or chronic stage. The bursae may be the first structures involved though all authorities are not equally agreed on this matter. The normal bursa is lined with mesothelium with its walls constantly in contact with each other except for a thin film of fluid; however, in a bursa which is the seat of an inflammatory process, there may be roughening and fraying and often complete destruction of its walls. This may involve only the subdeltoid or the subacromial bursae but it may be present in any or most of the thirteen or more bursae which may be associated with the shoulder, according to Meyer.[3] It is mainly these portions of the surfaces of the subdeltoid bursa which are brought into firm contact with every abduction of the arm. According to Codman, who wrote an excellent book called "The Shoulder," the subacromial bursa, the subdeltoid bursa and the subcoracoid bursa are one and the same structure although films of tissue separate them, depending entirely on the anatomic position and also whether the arm is in abduction or rotation. This same author states that "inflammation in the small sac of the bursa may be replaced by a number of smaller sacs and that practically all the lesions in the supraspinatus tendon are the most common cause of bursitis, just as lesions in the appendix are the common cause of appendicitis."[4] Though a few notable authors agree with Codman, there are many who are unwilling to stress the importance of this supraspinatus tendon as the source of all the pathology. The forces which destroy synovial surfaces also may produce similar changes in the underlying or surrounding structures. Thus there may be fraying and partial or complete destruction of considerable portions of the articular capsule. This same process may involve the tendons of the supraspinatus and infraspinatus muscles and may even affect the under surface of the deltoid muscle. The various ligaments which make up the shoulder joint may be the seat of partial or complete erosion. Small areas of necrosis eventually may lead to calcareous infiltration which in the X-ray appear as opaque deposits. These are seen in about one-third of the cases. These calcareous deposits vary in consistency and are composed of calcium phosphate and carbonate. All these changes about the joint lead to adhesions and cicatricial formation which are outside the joint space and which, on purely mechanical grounds, result in limitation of motion. In addition to the mechanical difficulties there is pain so that the patient soon learns to avoid these movements, the result being that the muscles lose their normal tone and eventually atrophy.

The usual onset of the disorder is a relatively sudden, severe attack of pain which frequently radiates down the arm and forearm to the thumb and first finger or else up the shoulder and into the lateral surface of the neck. This radiation of the pain is the reason why this condition so frequently is mistaken for neuritis. Due to the pain the patient does not move his arm in any direction and holds it firmly to his side. There is tenderness on pressure, usually accurately localized to one spot—the greater tuberosity of the humerus. Abduction of the arm both actively and passively is free up to approximately 60 degrees. From that point upward the pain is very severe and continues on to about 110 degrees, after which point abduction again may be free and painless. Between this range of motion the tender area impinges against the margin of the acromion. When the painful arc is passed the tender area lies protected beneath the acromion and not in contact with it, and the movement is painless. As the arm is brought down to the side there is once more sharp pain from 110 to 60 degrees of adduction. In the more severe conditions, in which the calcium deposit may be quite extensive, the degree of impingement against the acromion may be greater so that the abduction movement beyond the 60 degrees may be far too painful to be attempted. This sign of

pain on abduction of the arm is very characteristic of bursitis. Usually the so-called sawing motion is relatively easy and painless.

The acute symptoms usually persist for a week to ten days after which the condition on very rare occasions may be entirely relieved, or as is usually the case, may go on to the state of periarthritis with resulting adhesions and impairment of function. Thus after the first week or two, the symptoms continue except that they are not so severe. Pain is elicited mainly on attempted passive motion. Abduction of the shoulder is not only painful but difficult due to the obstruction encountered. Internal rotation is likely to be much more limited than external rotation. The patient has difficulty in carrying out these movements himself, partly because of the adhesions in the bursa and capsule and also because of the muscle atrophy which develops in a relatively short time. This atrophy may be detected easily in the deltoid muscle.

The treatment of periarthritis of the shoulder is approached from two angles—the general treatment of the patient and the local treatment of the shoulder.

The general treatment consists of search for foci of infection, in keeping with the supposition that an infectious process may be the etiological factor. The teeth, tonsils, genital tract or any other organ are investigated. It is my opinion that the theory of the foci of infection has been overemphasized in this disorder, very much as in chronic arthritis. Many patients have all their teeth extracted, the tonsils removed, the gall bladder drained and they still continue to have pain in their shoulder. The most rationale consideration for these structures is to consider them individually and if obviously infected they should be cared for by the accepted therapy today regardless of the symptoms in some other part of the body.

Often conditions other than the foci of infection must be investigated. Dickson[2] writes of the "importance of treating the general metabolic condition of the patient." He found several cases of periarthritis of the shoulder in patients who were being treated for severe hyperthyroidism for whom the treatment of the local condition in the shoulders by the various forms of physical therapy alone was extremely disappointing. On the other hand these same patients noted, after thyroidectomy, marked relief of the joint symptoms within from forty-eight to seventy-two hours. The intense pains subsided rapidly and with further use of physical methods there was a complete return to normal function. It is not uncommon to find this condition occurring at the time of menopause, and by the use of the estrogenic substances in relatively large doses together with physical modalities, marked improvement follows. Thus one treats the patient and not the isolated shoulder alone.

The local treatment will vary somewhat according to the duration and severity of the symptoms. In the acute cases where there is much pain and muscle spasm it often is time-saving to put the patient to bed. Too often a patient remains ambulatory and allows the arm to remain against the body in a sling which invariably results in marked limitation of motion and creates a severe disability to the individual. While the patient is in bed, the arm is fixed in moderate abduction of about 90 degrees and external rotation, which position may be secured by gentle traction from above and below the elbow. Some authors recommend full abduction but this seems to have no particular advantage and is likely to add to the discomfort of the patient. Ice caps or cold compresses are applied to the shoulder for twenty-four to forty-eight hours since any form of heat at this stage is likely to increase the pain. On the third day heat may be applied. It is better to begin with infra-red radiation on this day with a dose of fifteen to twenty minutes which may be repeated two or three times a day. About the fourth day more penetrating heat may be employed by means of the short wave diathermy machine. The application can be made either by the small condenser pads of the short wave diathermy machine applied to the anterior and posterior portions of the shoulder or by the use of the induction coil. For the first application it is well to keep the intensity low. When the condition is still moderately acute, a safe and less painful procedure is to apply the heat for three minutes, then turn the machine off for one minute and again turn it on for three minutes, and repeat these intervals until the patient has received a total of twelve minutes of heat. On the succeeding days this may be increased until the patient receives a total of twenty minutes.

Following the use of the heat, light stroking massage may be given. It is comforting and aids in the relief of muscle spasm. Then the arm is passively moved, once only, through the full range of abduction and internal and external rotation, if possible, and is then fixed

again in the original position. This treatment must be carried out cautiously and requires a certain amount of persuasion and tact. If the motion is started too soon or given too roughly, it will increase the reaction about the joint. On the other hand, if the arm is kept too long in fixation, the exudate becomes organized with the formation of firm adhesions. This type of treatment is carried out daily.

Gradually the range of active motion increases without pain and passive motion is permitted until full active abduction without discomfort is obtained. The patient usually is out of bed in seven to ten days, although treatments may be necessary for perhaps another week or two. It would appear that if the acute cases are properly managed, many of the prolonged periods of treatments which often are necessary could be greatly shortened.

However, not all cases are treated in this manner. Too frequently a physician will attempt to carry a patient through the acute phase merely by prescribing pain-relieving drugs, hoping that when this phase is over, normal function will return. Experience proves, however, that the vast majority of these patients with this type of treatment find after the acute pain has subsided that they do not have the normal range of motion. They are then referred to the physical therapy department which fortunately still can provide much help.

The treatments at this stage also utilize heat, massage and exercise. Heat is best applied by means of the diathermy machine either with the anterior-posterior technic of application with the pads or the pancake method with the coil. A new curved drum which fits over the shoulder recently has been introduced which is recommended because of its ease of application. It is well in this stage, too, to begin with a relative small dose of the short wave diathermy and gradually increase the time of exposure. Treatments should be given three times a week or daily if possible. Massage certainly should be utilized in this stage. Exercises both active and passive are necessary if the so-called "frozen shoulder" is to be restored to normal function. Since abduction and rotation movements are limited, they are emphasized, particularly external rotation. Since the normal shoulder cannot be abducted beyond the right angle when the humerus is held internally rotated, the return of external rotation must be secured before any appreciable amount of abduction can be regained. A simple exercise is to have the patient stand with his back to the wall, with his elbows touching it, and turn the forearms further and further out until the hands reach the wall. The patient also can attempt to touch the back of his neck or with his fingers clasped behind his neck move the elbows back into the position of true abduction. Then as external rotation improves, he will be able to reach over the top of his head and touch the opposite ear. As improvement continues, one frequently may use such simple devices as the shoulder wheel or the wall ladder or the overhead pulleys in an effort to increase the range of motion. Occupational therapy may be prescribed if available or at least the advantages of many of its worthwhile ideas may be suggested.

If after a trial of a few weeks with short wave diathermy, massage and active and passive motion, there is little or no improvement, and this is checked by means of recording the motion with a goniometer, the patient is a possible candidate for manipulation. This may be a means of saving a great deal of convalescing time. It is well to consider the general condition of the individual patient before this procedure is contemplated. I usually am opposed to subjecting an elderly or debilitated individual for such measures. On occasion I have seen injury to the brachial plexus following manipulation which was a far greater handicap than the limitation due to the adhesions about the joint. It is well to remember that manipulation must not be attempted in the early cases or as a matter of fact one should not even attempt forceful passive motion at this stage. Forceful treatment tears the already-inflammed tissues and increases the serofibrinous exudation.

However, manipulation has a definite place in the treatment of selected cases. It is well to bear in mind that there may be marked atrophy of the bony structures and very dense adherent bands, and care must be taken with manipulation to prevent dislocation or fracture. It goes without saying that before any joint is manipulated under anesthesia an X-ray must be taken. The manipulation usually is done under gas anesthesia. Several authors stress that only one motion should be attempted at a time. The majority of authors favor rotation of the shoulder joint both internal and external, for by these two maneuvers most of the adhesions are broken up.

The maneuver is more of a gentle, coaxing motion than actual forceful stretching. Too

ambitious manipulations lead to hemorrhage, injury to ligaments and tendons with the result that there is greater loss of range of motion than before the treatment. After the manipulation the hand is tied to the head of the bed in a position of abduction and external rotation. When the patient returns to his room, the head of the bed is elevated gradually so that the patient slides downward, which increases the abduction.

As soon as possible physical therapy treatment is resumed to prevent the formation of new adhesions. Heat and massage are applied again, and exercises both active and passive are attempted a number of times daily. Following the treatment the arm always is tied back in complete abduction and external rotation. This is repeated until the patient himself is able to adduct and abduct his arm in full range of motion. The patient then may be allowed out of bed to continue the treatments as an ambulatory patient. The speed of the progress will depend to a great extent on the number of adhesions about the joint and the duration of the disability.

Mennell[5] has made an important contribution to shoulder joint manipulation which is important for the physician who attempts the maneuver and also for the technician in attempting passive motion, by calling attention to the fact that movements of the shoulder joint are not those of a true ball-and-socket joint, like the hip. Instead of ball-and-socket motion, the head of the humerus glides on the surface of the glenoid, downward during abduction, and downward and backward in forward flexion. If not free to glide in this manner, down or down and back, in the stiff shoulder during manipulation, the greater tuberosity is forced up against the overhanging acromion and soft tissue injury results. He points out that if we wish to manipulate a stiff shoulder, our first task is to free the gliding motions of the head of the humerus in the glenoid. The first motion to reestablish this gliding is traction down on the arm. Then the humerus is adducted with the operator's hand in the axilla as a fulcrum. Then the head of the humerus is pressed backward in the glenoid.

If after a sufficient period of therapy there is no progress in motion, the patient may be anesthetized again and further maneuvers attempted. Of course this is not to be attempted repeatedly for one must admit that such procedures are not always conducive to a return of normal function. Patients afflicted with such diseases as diabetes, arteriosclerosis, hypertrophic arthritis and other disorders may be made definitely worse by repeated attempts with forceful manipulation. I recall one patient with hypertrophic arthritis of both shoulders who developed subdeltoid bursitis. The usual physical therapy treatment secured abduction of 90 degrees and sufficient rotation so that she could take care of her hair. She was not satisfied and resorted to manipulation under anesthesia. The end result was about 30 degrees abduction and no rotation. A tremendous amount of bony overgrowth developed about this shoulder which made further therapy useless.

Physical therapy measures cannot guarantee a return of 100 per cent function. One always should be honest and frank enough to admit that on occasion, a perfect shoulder joint cannot always be obtained. It is far better to discontinue the treatments when the maximum efficiency has been secured, which unfortunately may be short of normal, than to continue on indefinitely until the patient in justifiable disgust stops the treatments himself. By needlessly prolonging the therapy we bring discredit not only to ourselves but to the principles of physical therapy.

Summary

Periarthritis of the shoulder is a clinical syndrome often called subdeltoid or subacromial bursitis.

The etiology is unknown although trauma, infection and metabolic disorders are possibilities.

Pathologically the onset involves the bursae; later the other structures of the shoulder are affected leading to adhesions and cicatricial formation. The treatment includes general and local therapy. Physical therapy measures are the most effective, safest and the most satisfactory.

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Erb's Palsy

K. Armand Fischer, M.D.

It has been known in medical literature for many years that paralysis sometimes occurs in an upper extremity following a difficult birth, and this condition has come to be known as Erb's palsy, obstetrical paralysis, birth paralysis or brachial birth palsy. Erb's palsy occurs especially where force is exerted on the upper extremity during the manipulations accompanying the birth of the child. Smellie[1] was first to report this condition in his obstetrical practice in England in 1768. Duchenne described birth paralysis in 1872 and he recognized it as being a laceration process secondary to the trauma of a difficult delivery. Erb[1] in 1874 demonstrated how the different types of traction used on the after-coming head in breech deliveries was sufficient to cause injury to the brachial plexus nerve roots with resulting paralysis. Other writers have stated that a manipulation that predisposes greatly to brachial plexus injuries is in a head delivery when one applies traction to the head and neck to hasten delivery of the shoulders and trunk.

In the past a number of writers, including Thomas, Sachs, Whitman and Lange,[1] contended that birth paralysis is secondary to a shoulder dislocation or other shoulder joint trauma rather than the condition being one of a direct injury primarily in the brachial plexus. Sever experimented with infant cadavers and found that traction on the arm in abduction will bring about injury to the upper cords of the brachial plexus arising from the fifth and sixth cervical roots. These nerves are highest up in the brachial plexus and furtherest from the rotation center, so that they are pulled through a longer arc than the rest of the nerves and therefore are injured more easily. Sever found that if the clavicle were broken the injury more easily could be produced, and that it was hard to injure the eighth cervical and first dorsal roots under any conditions. He was unable to rupture the joint capsule, to separate the humeral epiphysis or to dislocate the head of the humerus in any of his experiments.

Scaglietti[3] in the late months of 1938 wrote that the majority of cases of disability to the upper extremity following birth are due to some trauma to the shoulder joint and its structures rather than due to a brachial plexus injury. He has been able to demonstrate by x-rays following the third week of life that there had been trauma to the epiphysis of the humerus or upper end of the shaft. He also states that there is shifting of the epiphysis of the humerus or upper end of the shaft. Some cases of shifting of the epiphysis he thought were due to trauma to the joint. This author did not offer any pathological evidence in support of his traumatic birth injury cases but relied mostly on the x-ray findings and physical signs.

In the face of the opposing views as to the causation of Erb's paralysis one must accept both theories as highly probable in this condition in the light of the proofs submitted by the various authors.

The essential pathology in obstetrical paralysis is varying degrees of injury to the brachial plexus, usually on one side. However, bilateral involvement occasionally has been seen. In some cases there may be hemorrhages around the nerves and in others there is bleeding inside the nerve roots. The fate of the nerves depends on whether the blood is absorbed or produces scarring. Other cases have varying degrees of tearing of the nerve cords and at times complete avulsion of the roots from their spinal attachments.

Following the nerve injuries flaccid paralyses are seen in the muscles supplied by the nerves. If the nerves are severely injured or avulsed they do not heal and total paralysis occurs. When only tears and stretchings occur the nerves heal with considerable scarring and partial paralysis results. Various degrees of muscular atrophy is seen with partial function. Usually certain contractures develop which are due to unbalanced muscle action and these result in deformities and distortions to the neighboring joints. The

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bones of the affected extremity do not develop normally, frequently being smaller and shorter. The epiphyses appear later than in the unaffected bones. These changes of the bone probably are due to nerve disturbances as well as lack of normal usage.

The signs and symptoms of Erb's paralysis vary with the location of the lesion and the extent of injury in the brachial plexus. Usually the newborn shortly after birth is unable to move the arm and it rests flaccid by the side of the body. The elbow is in complete extension or mildly flexed with the whole forearm and arm inwardly rotated, making the hand rest in pronation. The infant cries when one attempts any manipulation of the extremity. Rarely does one find any swelling above the clavicle or shoulder region and when noticed it is mild. In several days' time the child begins to recover from the apparent lifelessness of the limb by moving some part of the arm, forearm or hand. In mild cases improvement is rapid and return of function, once begun, soon is noticed in every part of the extremity, although a perfect recovery usually is not the rule.

There are three essential types of obstetrical paralyses seen; namely, the whole arm, severe or total type; the upper arm, moderate or Erb-Duchenne type, and the forearm, mild or Klumpke's type. The majority of cases are the upper arm type in which the fifth and sixth cervical roots are involved with loss of function usually in any of the following muscles, namely, the deltoid, supraspinatus, infraspinatus, biceps, teres minor, brachialis antius, coracobrachialis and brachioradialis. In the majority of cases the loss of function is only temporary and with the repair of nerves, the muscles again take on life. By the time the nerves heal completely a permanent shoulder contracture is present and maintained by the subscapularis in internal rotation, and pectoralis major and latissimus dorsi in adduction. The internal rotators of the shoulder have taken advantage of the paralyzed or weak external rotators by adducting and internally rotating the shoulder. A contracture results and it is impossible to externally rotate or abduct the shoulder normally. The deltoid muscle usually makes some recovery of function especially the anterior portion. This fact can be explained when we remember that the two portions of the deltoid muscle are supplied by separate branches of the axillary nerve arising from the fifth and sixth cervical roots, the anterior branch supplying the anterior deltoid and the posterior branch supplying the posterior deltoid with the latter nerve being affected more frequently than the anterior branch. The anterior portion of the deltoid elevates the elbow forward in the sagittal plane while the posterior deltoid abducts the arm laterally from the chest in the coronal plane. Since the posterior deltoid usually is affected the latter action frequently is lost.

Another group of cases, the whole arm, severe or total type, has involvement of all the cords of the brachial plexus, and the whole extremity as well as the shoulder is paralyzed. Later the shoulder may present the same contractures as do the upper arm paralyses but also an additional feature—namely, a pronation contracture of the forearm and frequently a wrist drop with very litle finger motion. This group shows improvement after several weeks, but they usually have a residual atrophy of the intrinsic hand muscles. A common contracture in this form of ailment is a flexion of the midphalangeal joints due to median nerve injury. The elbow is straighter than usual and the carrying angle is lost at times.

A third group of cases is called the lower arm type or Klumpke's paralysis. In this group the whole arm is involved temporarily, but the shoulder and upper arm group of muscles show a quick recovery. There remains a weakness of the long flexor muscles of the fingers as well as an involvement of the intrinsic hand muscles with complete wasting of the thenar and hypothenar eminences. Together with these is seen at times an involvement of the cervical sympathetic nerves which manifests itself in a narrowing of the palpebral fissure, contracted pupil, drooping of the upper eyelid and at times a retraction of the eyeball. The latter symptoms are present when the eighth cervical and first or second thoracic nerves are injured, and they signify that a more serious injury to the plexus has occurred.

Sensory disturbances frequently are seen in the whole arm and lower arm types and only occasionally in the upper arm types. The anesthesia is found complete in the forearm and only occasionally is found above the elbow. Rarely is sensation of the upper arm, shoulder or internal aspect of the arm involved.

The muscular atrophy may be extreme where there is great damage to the brachial plexus, but it is rarely as extensive as the atrophy following infantile paralysis. The

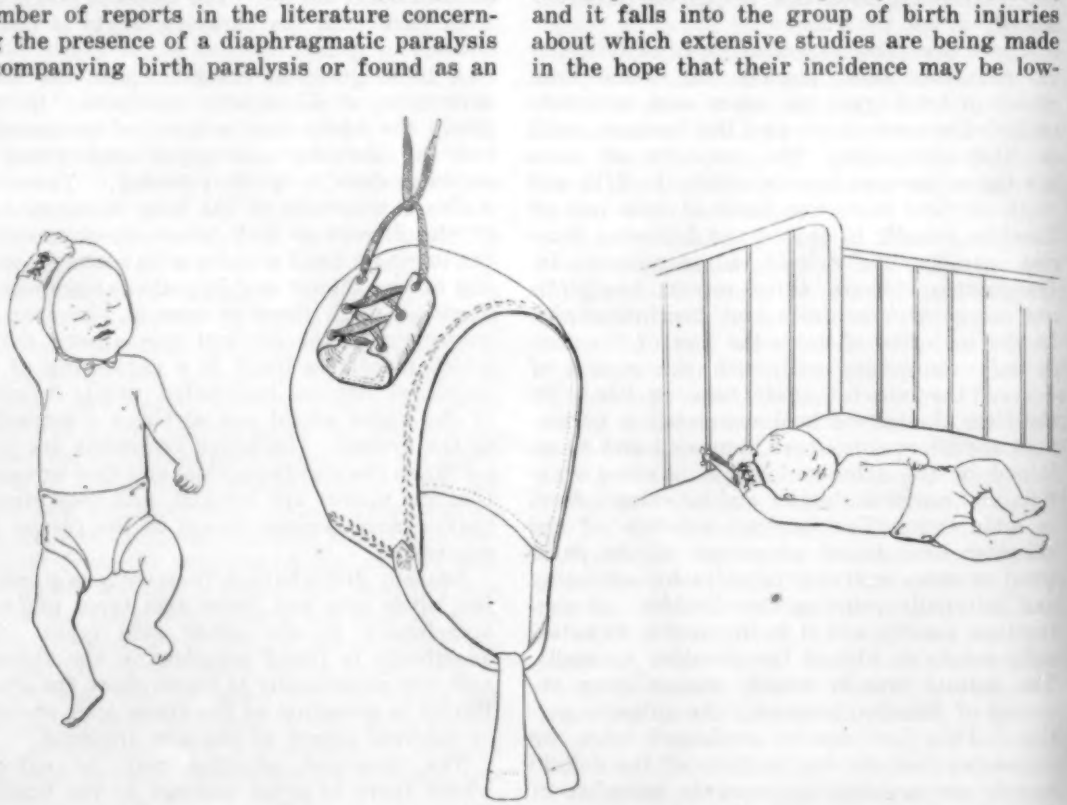
median nerve is less affected than the ulnar and where the forearm and hand muscles are involved the outlook for recovery is small.

As has been stated previously in this paper, there sometimes are associated shoulder joint complications. Fractured clavicles occur and, when present, a tear or rupture of the lower cords of the plexus often is found. Shoulder dislocations occur but usually not before several weeks following birth and are found mostly in the posterior position, although anterior ones are seen. Separation of the upper humeral epiphysis has been seen. In untreated cases of Erb's paralysis the acromion process of the scapula often may become hooked downwards over the head of the humerus which prevents normal abduction of the arm. Dislocations of the humeral head or hooking of the acromion process rarely occur under one year of age. Another finding that is not quite as infrequent as is usually stated is a subluxated head of the radius.

The three types of obstetrical paralyses described are seen most frequently, but at times the lesions are mixed. There are a number of reports in the literature concerning the presence of a diaphragmatic paralysis accompanying birth paralysis or found as an isolated lesion. The phrenic nerve gets most of its fibers from the fourth cervical nerve, but in addition it receives branches from the third and fifth cervicals. Occasionally the fibers from the fifth cervical may come to the phrenic through the nerve to the subclavius muscle. One always should keep this lesion in mind in Erb's palsy, especially when the child has any cyanosis or rapid and irregular breathing. Recovery of the diaphragmatic function usually occurs within from a few weeks to nine months' time.

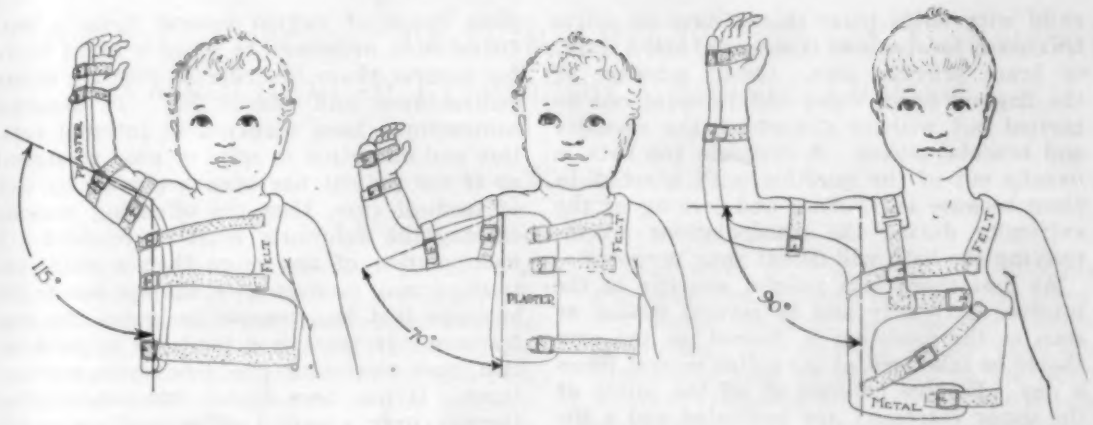
A definite prognosis in obstetrical paralysis cannot be made until after the first year of life when the permanency of the involvement is evident. A few cases obtain almost complete recovery after several months. Generally the upper arm cases give a good prognosis as regards return of function while the whole arm and lower arm types are permanently disabled to some degree.

The treatment of Erb's paralysis should start with the prophylaxis against this condition. That obstetricians are fully aware of the importance of this paralysis I am sure, and it falls into the group of birth injuries about which extensive studies are being made in the hope that their incidence may be low-



METHOD OF IMMOBILIZATION OF ARM OF NEWBORN WITH ERB'S PARALYSIS

Figure 1



1 PLASTER OR METAL SPLINT TO HOLD ARM ABDUCTED, ELEVATED EXTERNALLY ROTATED, SUPINATION OF FOREARM IN EARLY ERB'S PARALYSIS

2 PLASTER SPLINT OR BRACE WITH ARM ABDUCTED AT 70° EXTERNALLY ROTATED WITH SUPINATION OF FOREARM. USED AFTER 3 OR 4 WEEKS

3 METAL BRACE OR SPLINT USED IN LATE TREATMENT OR POST-OPERATIVELY

Figure 2

ered. Orthopedic surgeons and physical therapists should not be too hasty in their criticisms of obstetricians, because there have been cases recorded which developed Erb's palsy when no physician was present and the delivery was spontaneous.

Following the birth of each child a thorough inspection of the function of the extremities is made by the obstetrician in his routine examination of the baby, and in Erb's palsy he finds a paralyzed arm, forearm or hand. Usually the babe will flinch or cry on passive motion of the injured extremity when being washed or handled and the attention of the nurse or physician may be attracted by this. When a flail and limp upper extremity is found it usually means only one thing—a brachial plexus injury.

The symptoms of Erb's palsy are quick in appearing and may clear up rapidly when immediate treatment is instituted. In the early treatment the extremity is placed in a relaxed position with the hand and forearm above the head, abducting the arm, flexing the elbow and externally rotating the shoulder. This shortens the distance between the exits of the nerve roots and the acromian process, thereby taking any tension off the plexus in the hope of bringing any torn fibers closer together in a favorable position for healing. This position is retained by fastening the hand to a cap on the head; or to the upper end of the crib, or by plaster. Also certain metal splints and braces have been devised for maintaining this position, and a simple one should be fitted as soon as possible. The best brace is one which abducts the shoulder to 90 degrees, flexes the elbow to 90 degrees and holds the humerus externally rotated until the forearm lies in the coronal plane, with a completely supinated forearm, the hand, wrist and fingers being maintained in extension in a straight line with the forearm. Maintaining any more than 90 degrees abduction of the shoulder for more than several weeks might predispose to subluxation. Some authors advise that abduction be maintained only at 70 degrees from the trunk in order to prevent a subglenoid dislocation. At no time should the arm be allowed to fall to the side of the body or your purposes may be defeated. Another reason why braces are used in the treatment of this condition is to prevent the tendency of the patients to develop contractures and deformities. Abduction and external rotation shoulder braces prevent forward movement of the elbow in front of the body and tend to eliminate the internal rotation contractures of the shoulder as well as prevent subluxations of the shoulder. Sever[2] and Moore[4] have designed excellent braces for older children, but usually a simple splint that has been cut out of aluminum with padding on it is all that is needed for the newborn. Braces also serve to produce a certain amount of stiffness in the shoulder capsule with contracture and fibrosis which partially fixes the joint in the best position for future function.

During the first few weeks after birth the

child with Erb's palsy should have no active treatment because rest is essential and a splint or brace provides this. Gentle massage of the fingers, hand, wrist and forearm can be carried out without disturbing the shoulder and brachial plexus. A complete tub bath is usually out of the question with a splint in place because the pulling and jerking of the extremity during the manipulations accompanying the bath will defeat your purposes.

At first there is a painful neuritis in the involved extremity and in several weeks, as soon as the condition is cleared up, the arm should be taken out of the splint several times a day. Passive motions of all the joints of the upper extremity are instituted and a little later active motions are started. At the removal of the spint one may use massage, if it has not already been started by that time. As the function gradually returns the splint or brace is left off for gradually increasing periods during the day and should be replaced during the sleeping periods and at night. After several weeks the shoulder, elbow, forearm, wrist, hand and fingers should be placed through all normal ranges of motion several times a day to prevent contractures. This is an important point to be stressed by the physical therapist in giving instructions to the parents. A well-trained physical therapist always should guide the mother in these treatments, stressing the fact that the splint should be placed back in place under the extremity when treatments are finished. When motions in the muscles appear, one should gain the interest of the child by offering him toys, nursing bottles or other objects to promote usage of the involved extremity.

One should avoid the use of any electrical apparatus on children because such muscle stimulations cause pain which frightens and upsets the children. Sometimes half the battle in treating Erb's palsy is maintaining the confidence of the children. However, heat lamps and nonpainful thermal radiations can be used prior to massage and manipulations. The patient is kept on a routine as mentioned for several months unless there has been so little recovery that one must consider at times the possibility of surgical repair of the nerves as an avenue of hope in recovering the lost power in the extremity.

A patient with Erb's paralysis should continue with physical therapy guidance for several years after birth and every effort should be made to impress the parents with the necessity of putting the extremity through a complete range of motion several times a day. Often it is necessary to wear a night brace for several years in order to prevent severe contractures and disabilities. If shoulder contractures have occurred in internal rotation and adduction in spite of good treatment or if the patient has been neglected by lack of medical care, then the offending muscles causing the deformity must be released. A manipulation of any more than a mild contracture may produce bone damage due to the leverage that is necessary to loosen the contracture. If there is a tendency to subluxation, then stretching produces worse contractures. It has been found that conservative therapy over a period of several years will give a certain number of useful arms, but at times quicker results may be obtained from some of the operative procedures followed by intensive physical therapy.

In the postoperative care of patients, if physical therapy is not intelligently given, although the operative technique has been perfect, one is very likely to have a poor result in the end. It usually takes months of patient care to make any muscle transplants work in their new location and for unused muscles to regain functions when the limbs have been operated upon and placed in suitable positions for proper usage. This part of the care of Erb's palsy cannot be emphasized too much.

In conclusion, the final results in the care of Erb's palsy will depend on many factors and among the important ones are:

1. The extent of the birth injury.
2. Intelligent parents who can grasp the significance of the condition and the need for persistent care by physician and physical therapist.
3. The stamina of the patient and parents.
4. The financial status of the patient.
5. Emotional status, intelligence and temperament of the patient.
6. An intelligent and well-trained physical therapist.
7. And last the ability of the surgeon to direct parents, patients, physical therapist and to apply the needed operations.

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Physical Therapy and the Production of Collateral Circulation in Peripheral Vascular Disease

Lawrence N. Atlas, M.D.

During recent years physical therapy has come to assume a recognized and important place in the treatment of peripheral vascular disease, particularly in those affections of the peripheral arteries in which the growth of a collateral arterial network is the primary therapeutic objective. Such is the case in Buerger's disease (thrombo-angiitis obliterans), arteriosclerotic disease and acute embolic occlusion. These pathological entities have this in common: in all, the arteries either suddenly or gradually are occluded by irreversible organic disease. In Buerger's disease, occlusion results from an inflammatory process, in arteriosclerotic disease from a degenerative process, in acute embolic occlusion from the lodging of a foreign body, usually a blood clot or a fragment of diseased cardiac endothelium somewhere in the peripheral arterial tree.

To a major extent, symptoms in these diseases are produced by an ischemia of the tissues which have been deprived of their normal blood supply. In all ischemic tissue there is present unoxidized metabolic products which, by an irritation of sensory extravascular nerve endings, produce pain. In addition an ischemic part is cold and the patient feels it is such, while the lack of blood results in a partial anesthesia of the sense of touch and so the part feels numb. Finally the lack of vitamin B results in a neuropathy with pain and paresthesias. These symptoms of pain, subjective coldness, numbness and paresthesias may be present constantly, even during rest, or appear only on exercise or exposure to cold. Permanent relief of these symptoms is dependent on the growth of a collateral arterial network.

The physiology of collateral circulation formation is easily grasped if a few basic facts are kept in mind:

1. In the extremities there is a network of small arteries anastomosing the branches of the main arterial trunks. Ordinarily this collateral network carries little blood; but should the main arterial tree become obstructed, this network, under favorable conditions, may hypertrophy to the point where it is capable of nourishing the tissues which have been deprived of their normal blood supply.

2. The influence stimulating a collateral network to hypertrophy is an increase in the quantity of blood flowing through it, and

3. From the standpoint of practical therapeutics, the quantity of blood flowing through a collateral network can be increased in only one way, and that is by relaxing the arteriolar capillary bed into which that collateral network ultimately empties.

This therapeutic method of increasing the volume rate of blood flow through a collateral arterial network by dilating the arteriolar capillary bed into which that network ultimately empties requires some discussion. From the standpoint of the body economy it is important that there be some mechanism which controls blood distribution. There is nothing in the way the heart contracts or in the nature of the blood itself which can determine, for example, the relative distribution of blood to the brain, to the abdominal viscera or to the extremities, during periods of intense mental activity, digestion or violent exercise. What then is the mechanism which controls blood distribution? It is a very simple one. The column of blood, like many individuals, prefers the path of least resistance. It flows where the going is easiest. Resistance to blood flow resides primarily in the arteriole. The arterioles are minute muscular arteries which connect the smallest branches of the larger arterial trunks with the capillaries. They possess the ability to vary their caliber in response to the metabolic needs of the surrounding tissue. When that tissue requires nourishment, the arterioles

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dilate, resistance to blood flow is decreased and, under the head of pressure furnished by cardiac and aortic systole, blood pours through the arteries and arterioles into the capillary bed where the necessary exchange of nutriment takes place.

This brings us to the question of why it should ever be necessary therapeutically to stimulate the growth of a collateral circulation. Since there is an increased concentration of vasodilating metabolites in every ischemic region, why should not a collateral arterial network hypertrophy automatically as arterial obstructions develop? As a matter of fact this actually happens in a large number of individuals suffering from occlusive peripheral arterial disease. I have seen many persons in whom the main arterial tree had been occluded by an embolus, Buerger's disease or arteriosclerosis who had developed a very satisfactory collateral circulation spontaneously and who were symptom free. These individuals require no treatment, but they should be given detailed instructions concerning the care of their feet; because while their collateral circulation is sufficient for their ordinary metabolic needs, it may not be able to meet the added strain of an infection or injury, in which event gangrene ensues. On the other hand, should the arteriolar bed into which the available collateral network empties remain constricted despite the presence of these vasodilating products of ischemia, an effective collateral circulation will not form spontaneously, and symptoms of ischemia eventually will appear. It is in these individuals that the efforts of nature spontaneously to form a collateral circulation must be supplemented by therapeutic dilating measures.

To summarize, there are certain basic conditions, the presence or absence of which will determine whether, in any given case, an attempt to build a collateral circulation is likely to succeed or to fail: (1) The anastomotic channels must not be so diseased as to be incapable of dilating. (2) The arteriolar capillary bed into which they empty must be capable of dilating. (3) The treatment used must be capable of producing the desired dilatation.

This brings us to a consideration of those physical therapy methods capable of stimulating the growth of a collateral arterial network by dilating the arteriolar capillary bed into which that collateral network empties. The methods available fall into two main categories according to their mode of action. The first group comprises those methods which act through the application of heat. They are: (1) warm baths and soaks, (2) the whirlpool bath, (3) the lighted heat cradle, (4) short wave diathermy, and (5) fever therapy.

The second group comprises those methods which act by increasing temporarily the local concentration of vasodilating metabolic products with a resultant reactive hyperemia. They are: (1) Buerger's exercises, (2) the oscillating bed, (3) the suction pressure boot, and (4) the intermittent venous occlusion machine.

A detailed discussion of the technic of administering these various modalities is not necessary in this article, because the information is readily available elsewhere. However, I should like to bring to your attention the practical application of certain facts concerning their mode of action and also certain precautions to be exercised in their use.

First, in regards to those methods utilizing heat, in one form or another, it is of the utmost importance that these patients not be burned. Burns in the presence of peripheral vascular disease invariably terminate in gangrene, in which event, the limb and life of the patient are jeopardized. The use of such uncontrolled heating devices as the infra-red lamp, electric heating pads and hot water bottles is positively dangerous.

Then there is another factor to be considered in the utilization of heat in peripheral arterial disease. Heat not only dilates the arteries, it also raises the metabolic activity of the surrounding tissue. If this metabolic activity is raised to the point where the impaired circulation cannot meet the strain thrown upon it, pain results and the treatment is frustrated. For that reason, all baths and soaks should be given at a temperature of 90 to 95 F. One of the advantages of the whirlpool bath is that the temperature of the water can be meticulously controlled. When lighted heat cradles are used, they should be regulated thermostatically. It sometimes happens that in very advanced peripheral arterial disease a limb heated at temperatures as low as these will become cyanotic and very painful. The mistake often is made in these cases of administering more heat with the idea that it will somehow or other increase the flow of blood to the ischemic tissue. This is illogical and dangerous. Pain and cyanosis appearing after the administration of mild heat indi-

cates a fixed arterial bed which is incapable of dilating. Under these circumstances the continued administration of heat merely increases the metabolic activity of an already overburdened tissue and hence increases the risk of gangrene. Diathermy, applied to the calves of the legs, is of particular value in aleviating the pain of intermittent claudication. If the current used is too strong, the pain may be reproduced, in which event the current should be reduced to the point where only gentle warmth is felt. Fever therapy is reserved for acute cases of thrombo-angiitis obliterans who are otherwise in good health.

We now come to a consideration of those methods which produce a reactive hyperemia by temporarily impeding the flow of blood through the capillary bed. To accomplish this, Buerger's exercises and the oscillating bed utilize the effects of gravity, while the suction pressure boot and the intermittent venous occlusion machine impede blood flow through the capillary bed by intermittently compressing the veins in the thigh or arm. The capillary loops are extremely thin vessels, the walls of which consist of a single-layered thickness of endothelial cells having the properties of a semipermiable membrane. Between the capillary loop and the surrounding tissues there is a very delicately adjusted balance of hydrostatic and osmotic pressures. Normally this adjustment is such that from the arterial end of the capillary, nutritional substances pass into the tissues, while into the venous end of the capillary pass various products of metabolism. Should the flow of blood through the capillary be impeded, the pressure within the venous end of the loop rises, the balance of hydrostatic and osmotic pressures is disturbed and products of metabolism can no longer pass into the venous end of the capillary. Not being carried away, these metabolites collect in the perivascular tissue and increase in concentration to the point where they produce a dilatation of the capillary bed. For certain reasons which will not be discussed in this article, these vasodilating metabolic products, in the concentration therapeutically produced, do not relax the arteriolar bed as well as they do the capillary bed. For that reason, all of these mechanical methods and exercises should be supplemented by heating the limb while it is being treated.

It is unfortunate that the simple Buerger's exercises have been neglected for more complicated and expensive treatment. An excellent summary of the technic of administering Buerger's exercises and the results which can be obtained with them appeared in a recent publication.*

The intermittent venous occlusion machine possesses certain advantages which at times renders its use preferable to the suction pressure boot: (1) The machine, particularly one of the more recent models, is easily portable, making it suitable for home use. (2) It does not traumatize ischemic tissue. (3) It can be used uninterruptedly for several days at a time without untoward effects.

None of these mechanical methods and exercises should be used in the presence of infection, and in the presence of gangrene they should be used only with the utmost caution. There is another contraindication — vasospasm. Vasospasm is a nervous constriction of the arteries. It is very apt to be present in acute embolic occlusion and thrombo-angiitis obliterans. When vasospasm is present, mechanical measures and exercises can do no good and may do harm. For that reason they should be used in cases of acute embolic occlusion and thrombo-angiitis obliterans only after the presence of vasospasm either has been ruled out by proper diagnostic procedures or abolished by suitable measures.

In closing let me repeat that the purpose of this discussion is to show what physical therapy attempts to accomplish in the treatment of occlusive peripheral arterial disease, how it acts, and certain important precautions to be exercised in its use.

*Kaiser, Helen L.: The Use of Buerger's Exercises in the Treatment of Diabetic Patients with Peripheral Vascular Disease, Physiotherapy Review. Vol. 20, No. 1, January-February 1940.

Fractures

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Broken bones have been diagnosed and treated since the beginning of man's history. The Edwin Smith Surgical Papyrus, dating back to the fifth dynasty, some 4,500 years ago, apparently is a collection of case histories including records of fracture treatment. Egyptian mummies have been found with splints of bark well applied to fractures of various bones. The diagnosis of a fracture was possibly the earliest clinical diagnosis made, because a solution of bony continuity with displacement of the fragments can be seen and felt by the most untrained observer. There was nothing mystic nor abstruse about it. The similarity between a broken table leg and a broken human leg could not help but occur to the most primitive mind. Neither would hold up the weight it was meant to support, each could be mended by being straightened out and then bound up to something rigid.

Such may have been the simple and logical reasoning which was back of the early treatment of fractures. It was too simple, for it did not attract investigative minds. A broken bone was a broken bone, and that was that. The other organs of the body with their diseases were far less obvious, and therefore far more interesting. This resulted in a stagnation of knowledge of the processes of bone growth and repair, and concurrently a complacent acceptance of the existing treatment methods.

In 1741 the following paragraph was published in Cheselden's "The Anatomy of the Human Body."

"Bones are covered by a fine membrane, which upon the skull is called pericranium, elsewhere periosteum. It serves for the muscles to slide easily upon; it is everywhere full of small blood vessels, which enter the bones for their nourishment. . . . Bones grow by the continual addition of this ossifying matter; they increase till their hardness resists a further extension; and their hardness always increasing while they are growing, the increase of their growth becomes slower and slower, until they cease to grow at all. . . . In a fractured bone, in which the same kind of matter which ossified the bones at first is thrown out from the broken ends, there is formed a mass of callous matter." This was the general conception of bone repair just two hundred years ago.

However, new ideas and wider understanding were on the way. In 1736 a young surgeon in London dined with his friend, a calico printer; they had pork for dinner, a pig fed on the madder-soaked bran from the dye vats. The surgeon noticed the stained color of the bones and became interested. On his return home he fed his hens on madder-soaked grain and found the bones were stained in a manner similar to that of the pig. He published his findings in the "Transactions of the Royal Society" and went on to something else. The publication found its way to France where it was read by a keen observer, Duhamel. He repeated the madder experiments and carried them much further, proving to his own satisfaction the osteogenic function of the periosteum.

Time does not suffice to trace the steps of the investigations that Duhamel's experiments initiated. Bone was found to be a living, changing organ, a source of experimental investigation of rapidly increasing interest. It was found to contain bone cells, "osteoblasts," and a second school of investigators arose who felt that these osteoblasts, and not the periosteum, were responsible for bone repair.

Surgery was taking tremendous strides, and this new conception of bone repair was of great importance in its practical application to bone grafting procedures and the like. Amputations were giving way to more conservative operations for osteomyelitis.

However, the treatment of fractures was still in the ancient state. Plaster of Paris had been substituted for wood, more elaborate traction apparatus was devised than the rope and stone used by Guy de Chanliac in the Fourteenth Century, but the broken bone was

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an entity in itself, to be kept quiet until it united, with no attention paid to the surrounding soft parts. After the fracture was healed, attempts were then made to restore function to the extremity. The result was that in the closing years of the last century and the beginning of the present one, Mennell quotes Sir Arbuthnot Lane as saying, "The treatment of fractures, as it exists at the present, is a disgrace to surgical practice."

A drastic change was necessary, a change not only in method but in point of view. This was supplied by Lucas-Champonniere at the end of the Nineteenth Century. He advocated gentle, stroking massage and guided active mobilization in place of the heavy splints and absolute rest hitherto universally accepted. His teachings were carried on in England by Dr. James Mennell and won a gradual and grudging acceptance. Some of the results were strikingly good, less swelling, less pain, earlier and better motion.

But that was not the final answer; the pendulum swung back again. Few physicians had time or patience for the painstaking personal treatments necessitated by the method. Fractures still were treated by the junior interne in the accident ward or by the youngest physician in town.

In the last few years another factor has entered in—the close scrutiny of insurance companies and labor boards—and embarrassing questions have been asked. Why do these cases take so long to return to work? Why does the deformity persist? Answers had to be found and have been looked for, not only in the clinics but in the laboratories. The result has been a great awakening of interest in the fracture patient.

What is the modern conception of a fracture and its repair? How does this conception affect its treatment? As Dr. Clay Ray Murray has expressed it, a fracture is an injury to a patient involving a portion of the body in which there is a solution of continuity of bone. It is first of all an injury with all that the word implies—hemorrhage, death of tissue, local shock, possibly generalized shock. The injury may be minimal with only capillary bleeding, microscopic cell death and little edema, or it may be massive with torn muscles, contused nerves and even lacerated skin. The individual to whom this injury has occurred must be taken into consideration—age, sex, economic status, characteristics and general make-up all play a part in treatment and prognosis. The part of the body involved has a bearing. Must the patient be bedridden or at least not ambulatory? Can he carry the injured extremity in a sling and still go about his business? Is mobility a prime factor or is stability in weight-bearing? And finally we consider the broken bone itself. In other words attention is no longer focussed solely on the fracture. The soft part damage is of the utmost importance in the speed of restoration of function which after all is the end and aim of all treatment.

The sooner the soft part pathology returns to normal, the sooner will the circulation be restored, the muscle spasm relax, the joints move and incidentally, the bone unite. Bone heals primarily like any other tissue in the body. The extravasated blood clots and granulation tissue is formed, then the calcium dissolved from the broken ends in the acid PH of the tissue fluid during the initial stage of tissue death and circulatory stasis becomes deposited in the granulation tissue to form callus. This can happen only when the improved circulation has removed the products of tissue death and changed the reaction of the tissue fluid to a relative alkalinity. This is entirely a local process. If the damage is great with massive tissue death, much hemorrhage and later edema, the repair process will be slowed. If the blood and edema extend into the tissue planes and muscle bellies and remain there, scarring and fibrosis occur with the resultant diminution and delay in functional return. Treatment, therefore, should be directed not only toward the fracture but toward the soft part damage and should be instituted at once, not after the end results have occurred. Obviously the bone ends must be kept in place in order that further soft part injury is prevented and that the reparative granulation tissue is not destroyed. But any means that will improve the circulation to the part will aid in the repair—elevation, heat, stroking massage, active motion of such adjacent parts as may be safely moved.

I have called this the *modern* form of fracture treatment. "Proceed to put it (the forearm) up in such a way that the patient shall have his hand not lower than the elbow, but a little higher; so that the blood may not flow to the extremity, but be kept back." "At each change of dressing use plenty of warm water; indeed, douche copiously with warm water in all injuries of joints." "After bandaging the shoulder (after dislocation) you should proceed to fasten the arm to the side with some sort of band, passing it horizontally

round the body, and the shoulder should be gently and perseveringly rubbed. The practitioner must be skilled in many things, and particularly in friction (massage)." These quotations were written by one of the greatest doctors of all time, Hippocrates.

We have certain advantages, however, that were denied to Hippocrates. The physician is aided in his care of the fracture patient by the skilful and intelligent physical therapist, who as early as possible clears up the soft part pathology and restores function so that the broken bone, properly treated, results in a normally functioning extremity in a human being returned rapidly to his daily life.

Present Trends of Medical Exercise—A New Classification

Frank J. Wiechec

MEDICAL SPECIALTIES AND THERAPEUTIC EXERCISE

Exercise is so important to medicine that almost the entire field of occupational therapy is based on it. According to reports in the medical literature, the following specialties have utilized exercise in the treatment of disease. These specialties are listed according to the frequency with which they use exercise. Under each branch are listed the types of disease in which the patients have been benefited by exercise.

(1) *Physical therapy.*—Since nearly all the diseases, abnormalities, postoperative states or lesions, and other conditions listed below, are prescribed for by a physician specializing in physical therapy, and since the patients are treated by technicians, it is not necessary to enumerate the diseases in question.

(2) *Orthopedics.*—Fractures and dislocations; lateral curvatures of the spinal column and contractures; the state following arthroplasty, transplantation of tendons and muscles, and bone grafting; lumbosacral and sacroiliac affections; obstetrical paralysis, congenital contractures; bursitis.

(3) *Neurology.*—Spastic paralysis, hemiplegia, tabes dorsalis, Bell's palsy, tics, combined sclerosis, lesions of the peripheral nerves, progressive muscular dystrophy, neurasthenia, hysteria.

(4) *Internal medicine.*—Diabetes, pulmonary tuberculosis, arthritis, fibrositis, asthma, albuminuria (postural), pleurisy with effusion, pneumonia, obesity.

(5) *Vascular conditions (diseases of the blood and lymph vessels).*—Thrombo-angiitis obliterans, Raynaud's disease, occlusion of an artery, phlebitis, edema, varicose veins.

(6) *Pediatrics.*—Chorea, postural deviations, Still's disease, diabetes, spastic paraplegia, poliomyelitis, mental deficiency.

(7) *Obstetrics.*—Early pregnancy, prenatal and postpartum states, difficult labor, malpositions of the uterus, tendency toward abortion, relief of pressure symptoms, facilitation of labor.

(8) *Gynecology.*—Dysmenorrhea, amenorrhea, constipation, functional pelvic disorders, malpositions of the uterus, passive hyperemia in pelvis.

(9) *Cardiology.*—Mitral incompetency, aortic incompetency, myocarditis, cardiac neuroses.

(10) *General surgery.*—Scars, contractures, postoperative wounds, resection of ribs. (Breathing exercises and static postural positions are given to patients in many postoperative states.)

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(11) *Urology.*—Prostatic resection (active movements of legs).

(12) *Ophthalmology.* — Eyestrain and fatigue, strabismus.

NOMENCLATURE

A great variety of names has been given to the exercises used in medicine. Exercises are named for individuals who popularized their use and for the type of disease or the branch of medicine in which they are used. Some names are descriptive of the type of action that is being carried out. A search through medical books, medical journals and related literature has revealed that the following terms are used in speaking of medical exercise.

(1) *Descriptive of action.*—Active, passive, resistive, assistive, static, free, forced, strengthening, relaxation, coordination, breathing, creeping, rhythmic, recreational, reduction, corrective, preventive, precision, inhibition.

(2) *Apparatus.*—Elastic, table, water, bar, stick, loom, floor, mat, ring, ladder.

(3) *Diseases from which exercises have been named.*—Obesity, hemiplegia, spastic, poliomyelitis, combined sclerosis, tabes, fracture, scoliosis, postural.

(4) *Exercises named for individuals.*—Buerger, Allen, Schott, Stokes, Oertel, Frankel, Jacobson, Bressaud, Clow, Mosher, Klapp, Rockey.

(5) *According to country.*—Swedish, English, German, Danish, Indian (Yoga).

(6) *According to a field of medicine.*—Obstetric, neurologic, orthopedic, internal medicine, surgical, occupational, vascular, gynecologic, pediatric, physical therapy.

These names no doubt are descriptive of the functions that the exercises perform and honor individuals who have utilized them successfully, but the variety of names is confusing to the beginner, whether he be a medical student or student technician.

CLASSIFICATION

A few attempts at classification have been made but, as a rule, they are unsatisfactory because they apply only to one phase of exercise. Coulter and Molander[1] divided therapeutic exercise into two classes, passive and active, and divided active into assistive, free, and resistive exercise. They mention muscular reeducation and occupational therapy as other forms of therapeutic exercise. McGuinness[2] stated that therapeutic exercise could be divided into general and local exercise phases. She further stated that "For curative purposes exercises are either passive or active. Passive exercises consist of massage movements and passive movements at the joints. Active exercise may be single or duplicated and these latter may be assistive or resistive." McGuinness also mentioned special exercises that should be given for spastic paralysis, poliomyelitis, chorea and Bell's palsy.

McKenzie[3] stated: "The term 'exercise' comprises all movements, voluntary or passive, including manipulations by the hand of an operator or by a machine." He continues, "It falls into the two main divisions given by Plato—active and passive. Active exercise may be subdivided into, first, those involving a single effort of one or more muscle groups, such as lifting a weight or performing a feat on the parallel bars; and, second, exercises of endurance, consisting of motions rhythmically

TABLE I

THERAPEUTIC EXERCISE IN MEDICINE

Local

A. Local corrective
1. Passive
   (a) relaxed
   (b) forced
2. Assistive
3. Active
   (a) static
   (b) free
4. Resistive
   (a) concentric
   (b) eccentric
5. Hydrogymnastic
6. Apparatus
   (a) medical

B. Reeducational
1. Coordination
2. Relaxation
3. Inhibition
4. Rhythmic
5. Hydrogymnastic

C. Occupational
1. Major Crafts
   (a) weaving
   (b) woodwork
   (c) metalwork
   (d) basketry
2. Minor Crafts
   (a) needlework
   (b) beadwork
   (c) cord-knotting
   (d) block-printing

General

D. General corrective
1. Strengthening
   (a) symmetrical
   (b) asymmetrical
2. Stretching
   (a) creeping
   (b) hanging
   (c) traction
3. Postural
   (a) lying
   (b) sitting
   (c) standing
4. Respiratory
   (a) inhalation
   (b) exhalation
5. Calisthenic
6. Apparatus
   (a) gymnastic
7. Hydrogymnastic
8. Circulatory

E. Recreational
1. Passive
   (a) entertainments
   (b) concerts
   (c) radio
   (d) motion pictures
2. Active
   (a) gymnastic apparatus
   (b) rifle shooting
   (c) swimming (pool)
   (d) Occupational therapy
   (e) games
      (1) low organization
      (2) medium organization
      (3) high organization

repeated without great muscular expenditure for each one, and depending for their effect upon continuous repetition." The belief is prevalent among many workers that medical exercise consists principally of passive, active, assistive and resistive movements and some variations of these.

In my opinion there should be a more complete classification of medical exercises. Lack of such a classification prevents proper use of the exercises. An order or a classification of medical exercise is most necessary and especially so for teaching purposes. It is true that nearly all exercises fall into one of the four types already mentioned, but little is understood about the numerous technics or variations that have been evolved from these basic movements. These different combinations of movements have been used in treating patients having widely varying diseases. Each combination of exercises differs from another; it has its own rules for performance, speed, application and progression in difficulty. It is with the hope that a better understanding be accorded medical exercise that the classification contained in Table I is given.

The exercises are classified according to the scheme of Table I because therapeutically they have most often been applied according to such an arrangement.

A. *Local corrective exercises.*—These exercises are used to develop tissue (muscle, ligament, tendon) that has been diseased, traumatized or weakened through disuse. Their purpose is to strengthen and bring back to normal function individual muscles rather than groups of muscles. The exercises can be performed with or without apparatus, but they always must be done under the supervision of a physician. The movements are limited and require much concentration and effort. The resistance to effort is graduated according to the strength of the muscle. Local corrective exercises may be divided into the following types:

1. Passive exercise is movement which an operator or other outside force carries through without either the assistance or resistance of the patient. The chief objective of passive exercises is to maintain suppleness and so to prevent contractures and the formation of definite adhesions or the general matting of soft tissues. Passive exercises may be:

(a) Relaxed movements or small movements carried out with perfect ease and freedom by the operator; each movement may be imperceptibly greater than the preceding one. There is no pain involved for the patient, and the limit of movement is judged by the appearance of fibrillary tremors or muscular contraction.

(b) Forced movement is protracted (prolonged) steady pull over a region or a joint while a firm kneading massage is given the region to gain as much relaxation as possible. This exercise is used when the cause for its application is other than pure muscular disability (callous, inflammation, growths).

2. Assistive exercise is motion that is performed by active contraction of the patient's own muscles but with outside assistance of one kind or another. The assistance may vary from gentle support of the weight of the limb by a technician with the purpose of producing an effect similar to that of free motion, to the application of a considerable force to supplement and reinforce the patient's own muscles in forcing a motion to overcome a contracture or to stretch fibrous adhesions. The object is to enable the patient to accomplish more than he could if he were unassisted.

3. Active exercises are movements in which the patient's muscles are innervated and brought into motion through willful action and are free from outside assistance or resistance. These may include:

(a) Static or muscle-setting exercise which, although it is an active exercise, is not intended to be accompanied by any movement of joints. It consists of alternate contraction and relaxation of a muscle or group of muscles without the movement of a joint.

(b) Free movement is that form of body movement which is carried through as large a range as possible by the patient against the least possible resistance. To do this the body of the patient and the injured muscles are placed in such a position that gravity or friction exert no resistance to graded arc movements.

4. Resistive exercises are exercises with or without apparatus which offers resistance to muscular action. The resistance applied is different from the different phases of movement, least during the beginning and ending thirds, and greatest during the middle third of a muscle contraction. Resistive movements are divided into:

(a) Concentric movements in which both ends of the working muscles are brought

nearer to their respective centers and the muscles become shorter.

(b) Eccentric movements in which the muscles become longer while working; that is, their ends go farther from their centers.

5. Exercises performed on apparatus are used to strengthen or stretch local muscles or groups of muscles. Any one of the four types of movements mentioned can be obtained by these devices. Each apparatus demands a different technic for performance which must be learned by the technician before an exercise can be taught to a patient. The exercises may be administered with the aid of pulleys, skates, slings, smooth boards, bicycles, bars, rings and so forth.

6. Hydrogymnastic exercises are exercises carried out with either the aid or graduated resistance of water. The object of the exercises is not general, haphazard movements of a whole part but definite, controlled and mentally directed movements of the individual groups of muscles. They have for their purpose the reactuation and control of local muscular function after partial loss of motion or long disuse. These exercises differ from the others in that performance and gradation of difficulty are different.

B. *Reeducational exercises.*—These exercises are directed at muscles in which the neuromuscular coordination in some way has been partially destroyed. The reflex arc has become involved, making it impossible for the muscles to move by means of the reflex mechanism, resulting in the loss of coordinated movement. Groups of muscles rather than individual muscles are involved. Usually the muscles involved have good tone, although there may be an imbalance in muscular strength between the antagonists. The purpose of the exercises is to gain control of the groups of muscles through coordinated movements. Reeducational exercises differ from local corrective exercises in that the muscles involved can contract actively under stimulation but they cannot be controlled by the will. They consist of attempts by the patient to make purposeful movements of involved groups, to control highly stimulated overactive muscles or to reeducate a sense of position or feeling in anesthetic groups. The following types of exercise are found in this class:

1. Coordination exercises are exercises whose purpose is to bring about coordinated movements of joints and the regions of arms or legs. This can be accomplished only by repeated purposeful movements executed by the patient. The patient is taught to think the movement out first and then to contract and relax groups of muscles to bring out the desired movement. An attempt is thus made to reeducate the impaired nervous system and to reestablish lost or enfeebled coordination and sensibility.

2. Relaxation exercises are exercises used to quiet muscular and nervous systems. These exercises are "general" when they include the entire body, and "local" when limited to a particular group of muscles or to a part of the body, such as a limb. They consist of actively willed relaxations of, first, large muscle groups, then smaller groups, and finally individual muscles. The aim is to relax the muscles further and further until they reach the zero point of contraction.

3. Inhibition exercises teach a patient voluntarily to inhibit a reflex, or to train him in immobility when he has an uncontrollable desire to move. The purpose of the exercises is to replace abnormal movements with normal movements.

4. Rhythmic exercises are swinging exercises performed either actively with assistance or passively by use of a mechanical device. Their purpose is to teach coordination, to gain relaxation or to stretch contractures.

5. Hydrogymnastic exercises are graduated exercises performed in water that have for their purpose the training of hyperactive muscles, to bring about a more nearly equal balance between antagonists, produce sensory sedation and aid in making coordinated movements.

C. *Occupational exercises*—Molander[4] states that " 'Curative occupational therapy' is a form of therapeutic exercise which requires a series of specific voluntary movements, initiated by the patient, which form component parts of a more complex and coordinated movement. This exercise is designed for the express purpose of securing definite end-results and is a direct incentive for sustained effort." Molander defined "curative occupational therapy" as referring "to that department of occupational therapy where chronic and even acute conditions of impaired motion are treated by properly applied exercise, especially in association with the various crafts."

Occupational therapy works with groups of muscles rather than isolated muscles. The exercises can be started when muscles have reached such a degree of strength that they

can perform movements actively and against resistance. The exercises can be divided into:

1. Minor crafts (needlework, beadwork, cord-knitting, block-printing, clay-modeling). These are included because the exercises are comparatively simple to learn and are not strenuous, the activities in most cases being limited to movements of the fingers, hands and arms.

2. Major crafts demand more effort and involve more groups of muscles. The exercises given are more complex and more motion is necessary to do the work than is the case with minor crafts.

(a) Weaving can be practiced by all classes of patients. The exercises given can be of the nature of either minor or major crafts and may be in the form of simple hand interlacings, box-weaving, simple table-loom weaving or weaving on large power-looms.

(b) Woodworking is one of the most interesting crafts available for men. It can be utilized for exercising both upper extremities, the back, shoulders and, to some extent, the legs.

(c) Metalwork is a type of craft more suitable for men than for women. It involves heavy exercise.

(d) Basketry, one of the oldest crafts, has a wide application in treatment. The fingers, wrists and shoulders seem to benefit most by this form of exercise.

It must be kept in mind that these exercise crafts are by no means the only ones used for therapeutic purposes. It also must be remembered that providing exercise is only one function of an occupational therapy department.

D. *General corrective exercises.*—Corrective exercises are provided for tissues that are normal in tone and nerve control. The disability may be in the various segments of the body where a group of muscles or a part is weakened or put under a strain, thus causing a deformity or a tendency toward deformity. There may be a slight muscular imbalance and some contracture but not enough to interfere with control of individual muscles or even groups of muscles or there also may be a circulatory disorder of the extremities. These exercises are given to correct deformities and circulatory disorders, to correct postural abnormalities and to increase general bodily strength. They consist of large muscular movements whose purpose may be to increase circulation, strengthen, stretch or loosen groups of muscles. The following are the most important types of exercises in this group:

1. Strengthening exercises are exercises used to increase the tone and size of groups of muscles which have been stretched, traumatized or atrophied because of disuse. The exercises may be active, active resistive, gymnastic (apparatus) or hydrogymnastic. The movements may be:

(a) Symmetrical—so-called two-sided exercises, used to build up muscular tissue evenly on both sides of the spinal column.

(b) Asymmetrical—so-called one-sided exercises, that is, exercises that are used to increase unilateral strength or the flexibility of one side of the body.

2. Stretching exercises are exercises given to straighten the spinal column, stretch a contracture, loosen adhesions or stretch contracted muscles. Among them are:

(a) Creeping exercises, with the patient resting on hands and knees for the purpose of stretching shortened muscles and to render the entire spinal column more mobile. The position involves flexion of the trunk upon the thighs which lessens the possibility of rotation in the lower portion of the spinal column.

(b) Hanging exercises or passive or active stretchings conducted by means of head slings, bars or rings to straighten the spinal column and stretch contracted muscles or ligaments.

(c) Traction exercises are passive stretchings or stretched positions of various segments of the body in a harness, on the floor or in apparatus.

3. Postural exercises are exercises whose purpose is to enable the patient to maintain correct posture (proper relationship of the segments of the body to each other) in the lying, sitting and standing positions. Postural exercises attempt to promote symmetrical development of the musculature, plus training in balance so that neuromuscular coordination will result in poised and efficient movement.

4. Calisthenics are active exercises executed on a cleared area and may be carried out with hand apparatus or without hand apparatus. These latter are known as "free exercises." When corrective exercises are unnecessary, general exercises are of value in stimulating circulation, improving muscular tone, increasing metabolism and improving sleep.

5. Exercises requiring apparatus are those

carried out with mechanical or artificial devices so constructed as to serve as a base or support on which are executed bodily movements not possible of execution on an ordinary floor.

6. Circulatory exercises are graduated exercises whose purpose is to build up cardiac muscles and to increase circulatory efficiency, as well as to increase the vigor and efficiency of the entire body. These usually are given as graduated, resistive local exercises or walking and hill-climbing activities. Other types are those given for vascular diseases of the legs, where the parts are raised and lowered to increase circulation in the extremities.

7. Respiratory exercises are breathing exercises that may be performed passively as well as actively. The size of the thorax is increased or lessened, depending on the condition of the lungs. The thorax is affected actively by movements of the arms and trunk or passively by percussion, vibration and pressures.

The exercises may be:

(a) Inhalation: exercises to increase the external aeration of the blood and so produce internal respiration. They also stimulate the venous return flow to the heart.

(b) Exhalation: The object is to reduce the size of the thorax, mobilize the chest and restore the lungs and thoracic cavity to their normal sizes. Each exercise begins with expiration and finishes with expiration, the aim being to teach abdominal rather than thoracic breathing.

8. Hydrogymnastic exercises are basic swimming exercises in fundamental positions to develop groups of muscles weakened by fatigue or trauma. The purpose of the exercises is to correct faults in alignment (balancing the action of antagonistic muscles controlling bodily segments).

E. Recreational exercises are active or passive activities which may be in the form of games, contests, crafts, entertainments, reading of books or changes of environment. They may be either motor, sensory or intellectual. The intensity of these exercises can be graded, and the effort expended may range from reading a book to running a race. Davis[5] states that recreational activities should be graded from the standpoint of complexity into "one response, many response and intermediate forms . . . transition from a one act movement to a many response movement."

Recreational exercises readily divide themselves into:

1. Passive (entertainments, concerts, radio, motion pictures). In the pursuance of these the patient is relaxed and performs no physical activity.

2. Active, or exercises involving a certain amount of motor skill, muscular coordination and intelligence. The activities may be in the form of play, exercises, competitive games or achievements in mechanical skill. An example of a few are:

(a) Gymnastic apparatus: demonstrations of skill, daring and strength.

(b) Rifle-shooting: competition with little activity, indicated in the presence of cardiac disease.

(c) Swimming: relaxation, fun, competition.

(d) Occupational therapy: construction, display of mechanical skill.

(e) Games: may be combative, competitive or aids to social development. They divide themselves into:

(1) Simple organization: few rules of play, simple skills, spontaneous reactions.

(2) Medium organization: beginning of some teamwork, definite rules of play, beginning of skill.

(3) Complex organization: highly organized teamwork and rules, intensive play and competition.

RULES FOR EXERCISE

A. *Local corrective exercises.*

1. Periods of exercise should be short in order that fatigue may be avoided. The exercises should be repeated often during the day with proper rest periods intervening.

2. The exercises should not be general but specific. Each group of muscles must be exercised separately in accordance with its special function, with proper rest periods intervening.

3. The exercise should be localized by fixing the adjoining parts of the body so they will not take part in the exercise. This is to insure maximal concentration and effort in the desired action and also to prevent substitution of other muscles.

4. Resistance should be given whenever possible, but it should not be given until the muscle is able to complete the arc of motion unaided.

5. Muscle-setting can be started as soon as muscle spasm subsides after the injury.

6. Each movement should be a voluntary active one, performed by the patient in response to a stimulus. If power is not present

the patient should attempt the motion with concentration while the technician carries out the motion "with help."

7. Exercises should be done slowly, carefully and steadily, causing each joint to go through as full a range of motion as possible.

8. Overfatiguing a muscle by performing a movement too rapidly or too many times should be avoided. Fibrillation or a weakened response of a muscle to stimulus are signals of approaching fatigue. No period should last more than thirty to forty-five minutes. There also should be a rest of from ten to thirty minutes after the exercise period.

9. Painful movements should be avoided. Active motion should not cause pain. Pain is the natural warning that continuation of such movements may produce additional trauma.

10. Any pain that passes off in an hour is not detrimental to the final success of the treatment. However, if there is an increase of pain and swelling or the range of motion is less the next day, too much exercise has been attempted.

B. *Reeducational exercises.*

1. The patient and technician should be alone in a room during the exercise period with no outside interference or distraction. The room should be quiet, warm and well-ventilated.

2. Both patient and technician should be comfortable and perfectly at ease. Complete understanding is most necessary. The technician must be sympathetic toward the patient and in turn must have his complete confidence.

3. Exercises should be performed slowly with an appreciable interval between the movements in order to give the patient time to concentrate. The initial movements should be simple and uncomplicated, and the succeeding movements must be carefully graduated in difficulty.

4. In general each exercise should be done approximately ten times, but the last movement should be done as well as the first, and if signs of fatigue appear, the number should be made less.

5. Exercises should commence with slow, coordinated rhythmic movements, beginning with the large groups of muscles before expecting to achieve control of the smaller muscles. The extremities should be exercised last.

6. Exercises should be carried out with the least amount of "overflow," that is, with as little effort as is required to produce a free and easy movement. Exercises should be directed by the aid of the patient's vision.

7. The part being exercised never should be pulled or moved suddenly.

8. Active exercises consciously performed by the patient are useful because of their definite action on the neuromuscular apparatus. Muscular coordination can be brought about only by using what is called in physical education the "brain-cord-muscle unit" and by repeated purposeful movements initiated and executed by the patient.

9. Perfection of all the simple exercises should be insisted upon before a patient attempts complicated ones, because failure will undermine the patient's confidence in treatment.

C. *Occupational exercises.*

1. Periods of work should be spaced with rest periods at frequent intervals at the beginning—the patient should work for five minutes and rest for three minutes. As the patient becomes stronger, the working time may be increased.

2. A muscle should be contracted as far as possible, then held for a short period of time before relaxing.

3. Motion should be carried through as full a range as possible.

4. The following are limits of fatigue which constitute an indication for discontinuance of work: (a) tiredness, general or local; (b) redness of a joint, heat or swelling; (c) dyspnea and cyanosis, and (d) disinterest in the work.

D. *Corrective exercises.*

1. The patient at first should exercise easily. Additional exercises can be added as the patient finds that he can do them without tiring himself.

2. Exercises in the lying position are of more value than those performed while standing, because when the patient is lying down the body is in good position without muscular effort and localized exercises may be used to more advantage than in other positions.

3. A patient should continue one set of exercises to be done lying down until he has knowledge of the use of the muscles involved. The aim is to teach good habits for daily use, not hard muscular effort.

4. The exercise should not be slighted by doing it half-way—an exercise should be carried through the complete range or its value will be lost. The proper position and move-

ment is the most important part of an exercise; therefore, one must always study the correct way to perform every separate exercise. The patient never should be in a hurry to complete a movement. It should be performed slowly and to the full limit of motion.

E. *Recreational exercises.*

1. These exercises more often than not are given in the form of games. They never should cause harm to the body or increase deformity.

2. The main purpose of these exercises should be diversional, to provide a change from regular work and to bring about physical as well as mental relaxation. They may be adapted and changed for any purpose.

3. The exercises in most instances should involve natural aptitudes and skills; there must be relatively few movements causing fatigue; they should be relaxing in nature.

4. Exercises should not be stimulating or tiring to the patient and should not call for much effort on the part of the patient.

5. A properly chosen activity (exercise or game), if presented in an understanding manner, will bring out any desired effect, whether it be recreational, educational or therapeutic.

Graduation of Exercises

A. *Local corrective exercises:*

1. Following injury, especially where there is pain, weakness and muscular spasm, the exercises should be carried out without movement or irritation to the part. This action is most satisfactorily performed by tensing the muscles or performing static exercises. At first only one muscle-tensing exercise should be given to each affected part. This exercise should be performed a few times each hour.

2. Gentle, relaxed (passive) movements applied to each joint a few times a day will prevent stiffness of joints.

3. As the patient's pain subsides and the patient gains in strength, free or assistive exercises (pulleys, sling, skate, powdered board, water, technician's aid) should be given.

4. As the patient's strength returns, additional exercises should be given to provide a change in the program and relieve monotonous repetition. The exercises should be done at least three times a day.

5. Graduated resistive exercises should be provided by the technician as soon as muscles can contract and move the part affected partly through the range of motion.

6. Active exercises should be given a patient to do alone as soon as he is able to move the part through the full range of motion.

7. The progression of difficulty of an active exercise should be from muscle-tensing to movement with the aid of gravity, then movement with gravity eliminated, then movement against gravity and finally movement against resistance and gravity.

8. At first an exercise should be performed a few times, the number of repetitions should be increased gradually and when the maximal number is reached (it should never be more than ten times for each exercise), the difficulty of the exercise should be increased. Then again only a few repetitions should be made of the new exercise.

B. *Reeducational exercises.*

1. Strength of movement should not be increased; only the complexity of the movements should be increased.

2. Each exercise or set of exercises should be mastered by the patient before he is allowed to proceed to more difficult exercises.

3. Large range movements should be given first because they are easier, and small range movements should be given last.

4. Control of groups of large muscles and proximal joints should be gained first, then control of the smaller groups should be acquired. The progression should be from large muscles and joints to distal muscles and joints.

5. The patient should be taught to do slowly and without restraint those things which he can do and then must be led gradually to the performance of more difficult or complicated movements.

C. *Occupational exercises.*—The complexity, difficulty or resistance of the work can be increased by:

1. Increasing the height or distance away from the work—shoulder frame or loom.

2. Changing the type of material—heavy cloth, thickness or hardness of wood, and so forth.

3. Increasing the length of material being used, as in basketry, the height of spokes and the size of reeds.

4. Adding elastics or springs to the apparatus being worked, as in using the foot-power loom.

5. Changing from minor to major crafts where increased complexity of work will add more interest to the exercise.

D. *General corrective exercise.*

1. The progression of exercises is usually from lying to sitting to standing exercises.

Progression is made from one to the other as soon as the patient has mastered the fundamental movements and can do them without too much effort.

2. Progression in difficulty and complexity of these exercises can be increased by:

(a) Performing movements against gravity or against resistance, such as may be provided by pulleys, dumbbells, elastic materials, apparatus, flying rings, parallel bars, horizontal bar, vaulting horse, water.

(b) Adding movements by other parts of the body in addition to the simple movement first given. These movements may be performed in the following sequence:

(1) Two movements of one part of the body or a simple exercise.

(2) Two simple exercises done in alternation.

(3) Two simple exercises combined (both performed at the same time, using two different parts of the body).

(4) Exercises of four movements of one part of the body.

(5) Exercises having four movements of one part of the body and two movements of two other parts of the body.

(c) Increasing the speed of the movements being performed by: (1) counting, (2) use of a metronome, (3) using musical selections, or (d) decreasing the base of support; that is, from standing position, legs wide apart, to standing position with feet close together; exercise on tip-toes; exercises balanced on one leg.

E. *Recreational exercises.*

1. Length of time in participation of an activity can be increased.

2. Progression can be achieved by going from a one response activity to an intermediate or transitional activity, then on to a many response activity. For example (a) hitting a ball; (b) catching and throwing a ball in a certain direction; (c) participation in a game.

3. From quiet games (no physical activity) to active games. From games of simple organization (relay races, singing games, imitations, spontaneous reactions) to mediumly organized games (dodge ball, volleyball, kitten ball, captain ball) to those of complex organization (soccer, hockey, football, baseball, tennis).

4 Dancing—steps can be taught (simple) in the sitting position, then steps standing with support and finally dancing with a partner.

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Inspection of Schools of Physical Therapy

The secretary presented a request from the Committee on Physical Therapy of the National Research Council that the Council on Medical Education and Hospitals of the American Medical Association inspect schools of physical therapy for their ability to provide physical therapy technicians and physicians specializing in physical therapy for military needs. It was moved that the communication be received and referred to the Council on Medical Education and Hospitals with approval.—*From the report of the Committee on Medical Preparedness, J.A.M.A., Vol.* 115, *No.* 14, *Oct.* 5, 1940.

Crippled Children in the United States

The number of crippled children registered in forty-five of the states of this country at the beginning of 1940 was 188,579, of which 29,849 were registered in New York, 26,953 in Illinois, 15,343 in North Carolina, 11,304 in Michigan, 10,174 in Texas and 10,049 in New Jersey. Poliomyelitis caused crippling in 36,271 of these persons under 21 years of age, cerebral palsy in 19,172, paralysis due to birth injury exclusive of cerebral palsy in 4,532, tuberculosis of bones and joints in 7,196, osteomyelitis in 11,112 and burns in 4,161.—*From the J.A.M.A., Vol.* 115, *No.* 13, *Sept.* 28, 1940.

A Review of the Diseases of the Muscular System

Part III. Electrodiagnosis and Treatment of the Diseases of the Muscular System

Albert T. Steegmann, M. D.

Electrophysiology. Success in the use of the electric current in the diagnosis and treatment of muscular diseases cannot be expected unless the underlying principles of electrophysiology are understood and evaluated. Changes in the contractibility of the skeletal muscles as the result of disease of the final common pathway already have been considered. The alteration of excitability and conductivity of the nerve fiber as the result of disease makes it necessary to employ an electrical stimulus which can be varied in rate, duration and intensity. These factors determine the number of individual nerve fibers in a nerve bundle stimulated at a given time. The "all or none" law applies only to the individual nerve fiber rather than to a nerve bundle. The use of radiant heat as a preliminary procedure before muscle stimulation is of value because a rise in temperature of the nerve fiber shortens its refractory period and probably facilitates conduction of the nerve impulse.

Motor nerve fibers are of large diameter. They have a short refractory period, a low threshold of irritability to stimulation with the electric current and a nerve impulse of rapid velocity. The effectiveness of a stimulus varies with the chronaxia of the nerve or muscle. If the chronaxia of a nerve and the muscle which it supplies differ by a ratio of about one to three, the muscle will no longer respond to the stimulus applied to the nerve. If the duration of the stimulus strength exceeds the chronaxia time, the effect is no greater than if the stimulus time is equal to the chronaxia time. Normally the nerve responds best to a rapid stimulus (i. e., 100 per second). Chronaxia of the nerve-muscle unit is increased by fatigue, by drugs such as curare and by disease. The rate of the electrical stimulus influences the phenomena of summation, contracture and tetanus previously described. With the constant or galvanic current, muscle contraction occurs only when there is a change in the intensity of the current strength. This is the Du Bois-Reymond Law. The intensity of the stimulus is directly proportional to the magnitude of the change of the strength of the current or, if the strength of the current is constant, to the rate of fluctuation. The nerve impulse started by the "make" of the current arises at the cathode, while that started at the "break" of the current arises at the anode. This is of minor importance in man because the unipolar technique of nerve stimulation is used almost exclusively. In unipolar stimulation the actual poles are of great difference in size. The dispersive or indifferent electrode diffuses the current over a wide area and reduces its effectiveness as a stimulus almost to zero. The active electrode, on the other hand, is small and concentrates the effective stimulus to a small area of skin overlying the nerve or muscle to be stimulated. In the nerve itself the physiological anode is that point where the current enters the nerve, and the physiological cathode that point where it leaves the nerve. The opening or closing shocks arise at these physiological electrodes. In spite of this it often may be observed in stimulating normal muscle that the contraction produced at the "make" of the current is stronger than the contraction occurring at the "break" of the stimulus. The mechanism that produces the initiation of the nerve impulse at the point of stimulation is not known. The electric current probably changes the ionic state of the

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tissues. The ions of the tissue electrolytes conduct the electric current and travel at different velocities according to their difference in electrochemical properties. Theories to explain these physical and chemical processes involve complex biological problems. The permeability of the cell membrane, the concentration and diffusion of ions in the tissues, the changes in the hydrogen ion concentration, and other factors must be considered. The importance of the rapidity of the stimulus already has been emphasized. If the frequency becomes too rapid, ionic movement is not of sufficient degree to produce neuromuscular stimulation. The normal chronaxia of a nerve may be about 1/1500 second. A rapid alternating current (faradic) would be an effective stimulus. In a degenerating nerve this may be prolonged to 1/50 second. An effective stimulus in such a nerve would have to be of a strength and type that is adaptable to the changed state of the tissue. The faradic current with a rapid impulse rising to a maximum in about 1/1000 second and recurring from eighty to one hundred times a second would be inadequate and would produce no response, but the galvanic current would meet this demand and produce a contraction. If the voltage is raised sufficiently in a given case, the chronaxia can be ignored. Muscle stimulation always should take into consideration the temperature, tone and state of fatigue of the muscle to be stimulated.

Electrodiagnosis. Electrodiagnosis was first employed by Duchenne, a famous French neurologist of the last century. He is credited with the discovery of a number of muscle disorders described in Part II.* Little improvement in the older method of testing with the faradic and galvanic current was made until the discovery in recent years that greater precision in the measurement of the stimulus could be obtained by the use of condensers which are capable of storing a definite quantity of electrical energy. The discharge of this energy occurs in a fixed period of time depending upon the capacity of the condenser. For practical purposes the classical method of electrodiagnosis is reliable, but the operator must be familiar with the technique and know the possible sources of error. The only equipment needed is an adequate source of faradic and galvanic current with means to vary its strength and suitable electrodes for testing. The faradic and galvanic currents have important differences in their electrical properties.

The Faradic Current. The faradic current is an induced alternating current with a high rapid rise of intensity of short duration in one direction and a low, slow and more prolonged fall in the opposite direction. The frequency is about one hundred times a second. The large secondary current occurring at the break of the primary current is probably the effective physiological stimulus. It lasts about 1/1000 second. The voltage of the faradic current is high and its amperage low. Its alternating character produces no polarizing effects in the tissues and the frequency is of sufficient rapidity to stimulate normal nerve tissue. It will produce a state of tetanic muscular contraction but can influence the muscle only by way of its nerve supply. This current is inadequate to stimulate diseased nerves or muscles deprived of their nerve supply.

The Galvanic Current. The direct or constant current is an undirectional flow of electrons at low tension. In electrodiagnosis and therapy the current is measured in milliamperes. Polarity is important and the negative pole or cathode easily can be identified from the positive pole or anode by placing the electrodes in tap water. When the current is turned on, bubbles of gas escape from the negative pole. The current may be obtained from dry cells, from a motor generator or from a vacuum tube rectifier that uses ordinary commercial sixty-cycle alternating current. The galvanic current can stimulate nerve tissue and the muscle itself when the nerve is degenerated. The stimulus at the make and break of the current can be varied sufficiently in intensity and duration to stimulate nerves or muscles with a prolonged chronaxia. With the ordinary type of testing electrodes, the stimulus lasts about one-half second.

Skin Resistance is important in medical work. It is lower in those parts of the body where the skin is thin and contains sweat glands. Radiant heat lowers the skin resistance by increasing the local hyperemia and by the production of sweating. This makes the current less painful. The skin resistance also is influenced by the use of electrolytes on the electrodes and by the size of the electrodes. The skin resistance becomes less after the current is allowed to flow for a time. This is demonstrated by the rise in the reading of the milliammeter. It is important to keep the electrodes well moistened with the electrolyte and to be sure the current is turned off before

*Physiotherapy Review, Vol. 20, No. 5, page 274, September-October 1940.

changing electrodes or making other adjustments.

For electrodiagnosis the patient should be placed in a comfortable position and the muscles to be tested should be relaxed and in the optimal position for contraction. The temperature of the room should be constant and free of drafts. After preliminary heating of the skin, a large indifferent electrode, two by four inches or larger, moistened with an electrolyte such as a weak salt or sodium bicarbonate solution, is placed upon the back or chest of the patient. The active or stimulating electrode usually is made of a small metal knob or disc less than one inch in diameter, covered with gauze, asbestos or chamois skin. There should be an easily manipulated device or switch to turn the current on or off. Familiarity with a given piece of apparatus is necessary to obtain consistent results. *The faradic current always is used first.* After a little exploration the motor point and minimal current requirements for a minimal but adequate muscle contraction easily can be found. Care must be exercised, especially in children, not to frighten or shock them by beginning with too much current strength. This will interfere with relaxation and mental composure desirable for good results. If the muscle tested responds easily to the faradic current compared to the normal muscle on the opposite side or within the normal range determined by previous experience with the same apparatus, the galvanic test is unnecessary. This response shows that the nerve supply to the muscle tested is normal.

In weak muscles with normal nerve supply, stimulus of fifty to one hundred per second is adequate. This may be produced by the faradic coil or by the interrupted sinusoidal current. In flaccid paralysis the stimulus rate for treatment is reduced to a few contractions or increased up to ten to twenty per minute. This can be obtained simply by interrupting the galvanic current with a switch electrode or by the slow sinusoidal current.

The nerve responds most easily to stimulation with a minimal amount of current at that point where it is nearest to the skin and the muscle responds best near the middle of the belly of the muscle where the motor nerve enters. These points are called the motor points and their position was determined in detail by the German neurologist, Erb. Such charts can be found in any textbook of neurology or electrotherapy. In nerve degeneration the motor point moves down the belly of the muscle toward its tendonous insertion.

The response of muscle to faradic current stimulation is continuous, tremulous or of tetanic character and lasts as long as the current flows until fatigue occurs. Clinically it is desirable to stimulate only long enough to obtain a single quick contraction. With galvanic current, stimulation contraction occurs only at the "make" and "break" of the current. This depends upon the strength of the current. Normally the nerve is more excitable than the muscle it supplies. If the nerve is diseased or degenerated, the muscle will respond to galvanic stimulation because of intrinsic excitability, but the contraction will be slow, worm-like or sluggish.

If the response of the muscle to faradic current stimulation is absent, greatly diminished or sluggish, the galvanic current is then employed. At the beginning the positive pole is chosen for the indifferent electrode and the negative pole for the active electrode. The current is gradually increased as the key is pressed at regular intervals until a motor point is found where the muscle will respond to stimulation. The amount of current necessary to produce a minimal perceptible contraction is measured. It may be possible to feel the contraction over the muscle tendon when no visible contraction can be seen. Exhaustion of a very weak muscle must be avoided. The contraction of very weak muscles may be missed entirely by careless testing. On the other hand, the muscle may contract with less current after a few successfully induced contractions. It is important not to confuse the contraction of nearby stronger muscles which may contract by irradiation of a strong testing current with that of the weaker muscle being tested. If this occurs, "bipolar testing" over the belly of the muscle with two small electrodes will give a more concentrated current to the desired region. The muscle deprived of its nerve supply will show intrinsic contractibility to the concentrated stimulus. Since the degree of excitability varies considerably in different individuals and in different nerves or muscles of the body, only experience can teach one the finer points in technique with a given piece of apparatus. Textbooks on electrotherapy give tables of the relative excitability of nerves and muscles and the position of the motor points.

Many partially degenerated muscles may show a good reaction to faradic stimulation or the reaction may be a little sluggish. This can

occur because they contain sufficient normal tissue to mask the poor response of the degenerated constituents. It is important to be able to recognize a "quantitative" type of response to electrical stimulation. This means a normal type of response which can be elicited only if the strength of the stimulus is increased above the determined normal level. A weaker than normal stimulus produces a response when the nerve or muscle is hyperirritable, a condition known to occur in the irritative stage of a neuritis, in tetany and in conditions which lower the reflex excitability of the reflex arc. A "qualitative" response to electrical stimulation is indicated by a slow sluggish contraction of the muscle which can be induced only with increased current strength. The muscle may show a sustained contraction after the current is cut off or it may exhibit a slow relaxation phase. Rapid fatigue occurs in very weak muscles. If the muscle does not respond to the faradic current or if the galvanic current is able to elicit only the "qualitative" type of response, the reaction is called "the reaction of degeneration" (abbreviated R. D.). This type of reaction occurs in spinal or neural-neuritic muscular atrophy. The muscular dystrophies, on the other hand, show the "quantitative" type of change as a rule. The rapid exhaustion to faradic stimulation in myasthenia gravis was termed by Jolly the "myasthenic reaction." The prolonged tetanic contraction that persists for a number of seconds after the current is shut off in Thomsen's disease has been referred to as the "myotonic reaction" of Erb.

The complete reaction of degeneration shows the following characteristics:

(1) The nerve does not respond to stimulation of the faradic or galvanic current.

(2) The muscle responds to the galvanic current but demands a larger current strength than normal.

(3) The type of muscle contraction, if obtained, is slow, sluggish or vermicular.

(4) Stimulation of the muscle with the positive pole used as the active electrode elicits an equivalent or better response than the negative pole. This reversal of the "polar formula" may or may not occur and it is no longer considered of great importance.

The complete reaction of degeneration always indicates a severe type of diseased condition of the anterior horn cells or peripheral nerves accompanied by secondary degeneration of the muscles. The regeneration of the muscle in such cases may not occur at all and under favorable conditions recovery is usually a matter of many months or years. The prognosis necessarily depends on the degree and nature of the pathologic process and cannot be determined by electrodiagnosis alone.

In partial reaction of degeneration the following changes occur:

(1) Decreased excitability to the faradic current.

(2) The response to the galvanic current may be increased (irritable stage) or the response may be slow or sluggish but not to the same degree seen in complete R. D. The response to the galvanic current may vary in partial R. D. from a slight change to complete R. D.

In partial R. D. the prognosis ordinarily is more favorable for recovery provided the disease is not a progressive type. Partial R. D. may represent only a stage before complete R. D. in progressive diseases and can lead to erroneous conclusions unless the stage of the disease is recognized. In conditions with a favorable prognosis, recovery may occur in from one to four months. If no R. D. is present, recovery may occur in only a few weeks. A good faradic response ordinarily rules out an organic disease of the anterior horn cell or peripheral nerve. It is of particular value in differentiating an hysterical from an organic paralysis. It is important to emphasize that too much reliance should not be placed on the results of a single electrical examination. This procedure is so simple to carry out that repeated tests should be made and accurate records kept. Repeated tests can be of great service to the physician in choosing suitable methods of treatment and in studying the rate and degree of recovery.

For more accurate electrodiagnosis, determination of the chronaxia has been developed. As stated above, the chronaxia is the shortest time a current of a certain defined strength must flow through a given nerve or muscle to produce a muscular contraction. It is measured in terms of the rheobase voltage which is the minimal value of a galvanic current that will produce a perceptible contraction of the muscle when allowed to flow for an indefinite period of time. It was found that double this amount of current would produce a contraction of marked magnitude and efficiency if allowed to flow from 0.0001 to 0.0007 seconds. The procedure is carried out as follows: (1) Determine the rheobase voltage by unipolar

galvanic stimulation using the negative pole as the active electrode. Double this voltage is now used to charge a series of condensers which vary from 0.01 to 50 micro-farads capacity. (2) With the electrodes left in the original position, discharge these condensers individually beginning with that of smallest capacity until a contraction of the muscle occurs. The condenser of smallest capacity that produces a contraction is the one that indicates the chronaxia. This can be calculated by the formula $T = RCK$, where $T =$ time chronaxia; $R =$ the resistance of the circuit; $C =$ capacity of the condenser, and $K =$ an experimentally determined constant.

TREATMENT OF THE DISEASES OF THE MUSCULAR SYSTEM

With few exceptions the use of physical therapy is the most valuable type of therapy for the diseases belonging to this group. For convenience, the treatment can be divided into three types: (1) medical therapy, (2) physical therapy, and (3) orthopedic therapy.

Medical Therapy. In the acute anterior horn cell and peripheral nerve diseases, complete bed rest and general medical measures to prevent complications are employed. Paralyzed muscles are put in splints in the relaxed position. Respiratory paralysis in poliomyelitis is treated with the Drinker respirator, if available. In an acute neuritis the same principles apply. Pain must be relieved with opiates if necessary. In the neuritides the elimination of toxic agents (i. e., alcohol), the use of vitamins (especially the B complex) and a high caloric diet are essential. In traumatic nerve lesions suturing of severed nerves is absolutely necessary before recovery can occur. This can be done at the time of injury or at a later date.

In the muscular dystrophies and in myasthenia gravis, a number of drugs have come into use in recent years. In 1930 Edgeworth introduced ephedrine sulfate for the treatment of myasthenia gravis. This drug apparently gave a more prolonged action than adrenalin which has been used to reduce muscular fatigue. In 1932, Thomas and his coworkers used glycine (amino-acetic acid), one of the simpler amino acids, in the progressive muscular dystrophies. Remen, in the same year, employed glycine in myasthenia gravis. This drug was thought to improve the metabolism in the muscle by building up the phosphocreatine.** It caused at first a rise and later a fall in the urinary creatine excretion and was accompanied by improvement of muscle strength and endurance in the patient. Another advance in methods of treatment appeared in 1934 when Walker introduced physostigmine in the treatment of myasthenia gravis. A year later Pritchard reported beneficial results with prostigmin, a synthetic drug related to and having the same effect on the muscle but less side action than physostigmine. This drug probably acts by delaying the destruction of acetyl-choline by choline esterases at the myoneural junction. In 1935 Laurent and Walther showed that its effect is enhanced by the potassium ion. These drugs are of great benefit in myasthenia gravis. In the muscular dystrophies their value is less certain. They may produce subjective improvement in the patient. However, the same results have been reported after the use of vitamin D therapy. Quinine sulfate benefits patients with myotonia congenita (Thomsen's disease) but its action is not understood at the present time. In the progressive spinal muscular atrophies, drugs and other types of therapy are unsuccessful or of doubtful value. Wechsler recently has reported the successful treatment of two cases of amyotrophic lateral sclerosis with alpha-tocopherol (vitamin E). He suggests that it also may be effective in the muscular dystrophies. If further investigation proves that recovery is possible in these two diseases if treated early with vitamin E, it represents a medical discovery of the first magnitude.

Physical Therapy. The treatment of paralytic or weak muscles by physical agents following lesions of the anterior horn cells or peripheral nerves is of value if properly used. Great harm can be done if the type of lesion, stage of the disease and pathologic changes in the muscles are not considered.

In the early stage of paralysis the paralyzed muscles are put in a relaxed position and at complete rest by splinting. This provides protection to the injured tissues. The muscles are kept warm by mild radiant heat. It is important that the weak muscles be placed in a neutral position where they cannot be overstretched by their physiological antagonists. Protection is provided by padding the splints with a thick layer of cotton. For the relief of pain and muscle tenderness, heat from a light cradle is preferred and can be used almost continuously. The whirlpool or warm water bath also can be used. The heat

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promotes increased blood supply and aids in the carrying away of metabolites. The splints should be removed daily and gentle passive motion given to the joints and weak muscles. This must be done in the most gentle manner. Very light superficial stroking massage for its reflex and circulatory effect can be done without harm. After the stage of muscle tenderness is past (three weeks or longer), gentle massage of the weak muscles can be started. At first this also must be very gentle but can be increased as the tolerance of the muscle increases.

Electrical stimulation can be harmful if begun too early and carried out intensively. It should never be used in poliomyelitis until muscle tenderness has disappeared. Some writers are opposed to the use of electrical muscle stimulation in poliomyelitis. The value of such treatment needs more scientific investigation. The experimental work of Chor at present is incomplete but in time should provide evidence that will aid the clinician in the choice of therapy. A scientific rationale for electrotherapy is needed.

Electrotherapy. For electrotherapy, unipolar galvanic current is employed. It should not be started until muscle tenderness has disappeared. In very weak muscles only a few contractions are given at the first treatment and the number of contractions are increased slowly as the nerves to the muscles regenerate. If the muscles stimulated do not respond and nearby stronger muscles contract by spread of the stimulus, the bipolar method may be employed. The slow sinusoidal current is perhaps the least painful and most efficient current to use after the muscles are in condition to give a larger number of contractions (fifteen or more). Muscles with prolonged chronaxia contract best by stimulation with the smooth sinusoidal current. When the chronaxia is shorter, the best contractions can be obtained with the rippled sinusoidal current. The stimulus should be applied in such a way that the time given for relaxation is three or more times as long as that for contraction. If the relaxation phase of the contraction becomes prolonged it probably indicates fatigue (i. e., contracture) and stimulation should be discontinued. Electrotherapy will not prevent atrophy in a denervated muscle.

The folowing rules for electrotherapy are useful in avoiding dangers of the treatment:

(1) Use rest, heat, passive motion and massage for four to six weeks before beginning electrotherapy. In Bell's palsy, two weeks' time is sufficient.

(2) Muscle tenderness must no longer be present.

(3) If the muscles are tender to palpation or painful to stimulation the day following a treatment, either too early treatment or too much treatment has been given.

(4) Do not stimulate the muscles further if the relaxation phase becomes prolonged.

(5) If the muscle response to a given strength of stimulus is less than the response obtained when electrotherapy was first begun, discontinue the therapy.

It is doubtful if the adverse criticisms of electrotherapy in poliomyelitis would have been necessary if the above rules had been followed.

In the treatment of the muscular dystrophies, electrotherapy rarely is needed because the muscles almost always are capable of voluntary contraction. Otherwise the same principles apply. It is important in all of the muscular disorders to use medical or surgical measures to increase the general health of the patient.

The progressive spinal muscular atrophies and the dystrophies in general have a poor prognosis, but remissions occur in some cases of both groups. Carefully graduated and controlled exercises followed by heat and massage often will produce what is apparently a stationary course in some of these patients.

It is important to emphasize that electrotherapy will not increase the strength of weak muscles. This can be obtained only by exercise. It follows as soon as voluntary contraction of a weak muscle is possible—active exercise is the treatment of choice. This may be carried out under water or in a sling suspension. It is the purpose in this review to consider physical therapy up to the stage where electrotherapy is no longer needed. Therapeutic exercise, the correction of deformities and further phases of the treatment of muscular disorders are not described because the subject, being highly specialized, is given in detail in books on the subject. The reader will find several of these in the bibliography.

Orthopedic Treatment. The use of specially constructed braces and operative procedures in the treatment of muscle disorders belongs to the realm of the orthopedic surgeon and cannot be reviewed here. Such treatment often is necessary along with or after the stage when physical therapy is most useful.

Close cooperation between the neurologist, the orthopedist and the physical therapist gives the patient the benefit of the specialized training and knowledge of a group of physicians whose aims and ideals towards them are the same—namely, the maximal restoration of function that has been lost by the crippling effects of the disease.

Case Histories

1. *Progressive Spinal Muscular Atrophy (Scapulo-Humeral Type with Rapid Course)*

F. M., a 54 year old man, was examined March 3, 1937. He had had pain and stiffness in his joints for years and this had been aggravated by an attack of influenza a month before examination. One week before examination he noticed atrophy, weakness and twitching of his right upper arm and deltoid muscles. No sensory changes were present. Examination revealed atrophy of the right biceps, triceps and deltoid muscles with marked fibrillary twitching. The tendon reflexes were present and the right forearm showed no atrophy or loss of muscle strength. The abdominal reflexes exhausted easily. From the time of the examination, the muscle atrophy and weakness progressed very rapidly, spreading from the right shoulder girdle to the left shoulder girdle, the left upper arm and finally the pelvic girdle and thigh muscles. The forearms also became weak by the time the disease had involved both shoulder girdles. Symptoms of bulbar palsy began two months from the time of onset and progressed rapidly with nasal slurred speech, regurgitation of fluids through the nose, flattening and inability to elevate the angles of the mouth, atrophy and fibrillation of the tongue and inability to elevate the palate. He died with respiratory failure seven months after the onset of the disease. The rapid course of the disease in this case is striking. Within two weeks the tendon reflexes of the entire right arm became diminished, and they were absent in both arms within two months. On March 17, 1937, the spinal fluid was normal. The blood nonprotein nitrogen was 41.6 mg. per 100 cc., the blood urea nitrogen 20.3 mg. per 100 cc. and the blood creatinine 1.6 mg. per 100 cc. On August 18, 1937, the blood creatinine was 1.2 mg. per 100 cc.; the blood creatine 3.0 mg. per 100 cc., and the urinary creatine excretion in twenty-four hours was 165 mg. He died September 6, 1937.

The patient's past history was uneventful except for a peptic ulcer three years before the present illness. His family history is significant. His father died at fifty from an unknown cause, his mother is still living at eighty. He has one brother and two sisters living. One sister has Raynaud's disease. Another brother died at the age of forty-six with a progressive spinal muscular atrophy which ran a rapid course of about one year.

Comment. The rapid course in this case resembles that ordinarily seen in cases of amyotrophic lateral sclerosis, which can be excluded by the absence of the Babinski sign, increased tendon reflexes and other evidence of pyramidal tract disease. Both progressive spinal muscular atrophy and muscular dystrophy may be familial.

2. *Progressive Spinal Muscular Atrophy (Shoulder Girdle Type)*

S. G., a young man twenty-three years old, noticed weakness in his right upper arm in March 1935. A month before he had been dazed in a motor accident and his head had been jerked around to the right, but there was no apparent injury to the right arm or shoulder. A short time after the accident he noticed aching in his right shoulder which persisted for two weeks. Two weeks later he noticed weakness of the right upper arm. Atrophy of the right deltoid muscle with fibrillary and fascicular twitching was present ten weeks after the injury. The patient was examined again in November 1935. His right deltoid was atrophic and weak and there was marked twitching of the muscles of the right shoulder girdle and upper arm but no sensory changes. He was unable to hold the extended right arm forward or outward. The tendon reflexes of the upper arm were diminished. No pseudohypertrophy was present. There was no Horner's syndrome or X-ray evidence of cervical ribs. There was no history of past illnesses of significance and no familial history of any muscle disorder. The patient has been followed until the present time. His arm has become a little more atrophic but his muscle strength seems to be maintained. He was given corrective exercise, massage and general medical care.

Comment. This type of condition is more common in people at midlife. The relationship of trauma to the onset of the disease is not definitely known but some cases appear to be precipitated by injury.

3. *Familial Progressive Muscular Atrophy (Werdnig-Hoffmann Type)*

This disease was observed in a girl ten years old and in her four year old brother. They are of Hungarian descent. Four other brothers are healthy. There are no other members of the family known to have this disease.

(a) The girl, Mary, was first examined August 6, 1937. She was a full term baby without a history of abnormal or difficult birth. The muscular weakness was first noticed by the mother when the child was two and one-half years old, although the mother had observed peculiar twitching of the muscles for a much longer period of time. The weakness and atrophy of the muscles has been progressive. Examination revealed atrophy of the proximal muscles of the extremities and the girdles. The muscles are weak, have

poor tone and fibrillary twitching is present in the girdle muscles and deltoids. The abdominal muscles bulge and there is a compensatory lordosis and curvature to the left in the lumbar region. The tendon reflexes of the extremities are absent or very weak but the abdominal reflexes are still present. Atrophy of the muscles of the back is greater on the left side. There are no sensory or cranial nerve defects or evidence of pyramidal tract disease. The child is mentally normal. Examination of the blood was normal except for a fasting blood sugar of 64 mg. per 100 cc. and 31 mg. of urea per 100 cc.

(b) The boy, George, showed muscular weakness and stumbling when walking at the age of two and one-half years. Muscular jerking and twitching had been present from an early age. The muscles of the arms and back show fascicular and fibrillary twitching. He has weakness of the proximal muscles of the extremities, of the back and girdle muscles. The upper abdominal muscles bulge and he walks with a lordosis and some swaying. The tendon reflexes are all slightly exaggerated except the patellars which are absent. There are no sensory changes, cranial nerve defects or evidence of involvement of the pyramidal tracts. Examination of the blood was normal except for a fasting blood sugar of 48 mg. per 100 cc. of blood. Urinary creatine was not determined in either child.

A muscle biopsy was taken from the pectoralis major muscle in each child. Electrodiagnostic tests made over this area in the girl showed a fairly good reaction to the faradic current but in the more atrophic muscles of the left biceps the faradic response was poor and the galvanic current gave a slow, sluggish contraction with reversal of the polar formula. This indicates a reaction of degeneration. Electrical tests in the boy were not satisfactory because of his fear and emotional reaction to the electric current.

Histological examination of the muscle revealed in the boy small muscle fibers with increase of nuclei at the border of the muscle. Striations were preserved in most fibers but some fibers showed a homogeneous appearance in the central portion. Fat stains revealed tiny droplets of fat in bead-like rows with apparent replacement of the longitudinal myofibrils in the muscle fiber. The changes in the muscle of the girl were of the same type but more advanced with greater degeneration of the fibers, loss of striations and more connective tissue replacement of the degenerated tissues.

Comment. The age of onset was probably earlier than could be determined by the history. Otherwise the cases are typical.

4. *Progressive Muscular Atrophy (Aran-Duchenne Type)*

G. S., a man thirty-seven years old, was examined November 3, 1933. Two years before he noticed "stiffness" and loss of strength in his hands which became more pronounced when his hands were cold. About the same time he became aware of a "shrinkage" of the muscles of his hands. These changes were not accompanied by any changes in sensation or weakness in any other muscles. The weakness had progressed very slowly and interfered with buttoning his clothes and use of his hands in general. There was no past illness of significance nor any family history of muscular disorders. One brother had epilepsy. Examination revealed no muscular weakness or atrophy except in the hand which showed interosseous atrophy and some flattening of the muscles of the thenar and hypothenar eminences. His tendon reflexes were brisk and the plantar responses were flexor in type. The only unusual sign was absence of the left abdominal reflexes. The cranial nerves all were normal.

Comment. One might be inclined to consider this an early case of amyotrophic lateral sclerosis but the duration of two years without significant progression and the absence of definite pyramidal tract signs is against that diagnosis. Amyotrophic lateral sclerosis usually runs a more rapid course. A typical case is given below.

5. *Amyotrophic Lateral Sclerosis*

A. W., a fifty-three year old housewife, was examined May 15, 1939. A year before the examination she detected weakness in her left arm which slowly progressed. In December 1938, she began to have a stiffness and tendency to drag her left leg in walking. At the same time she experienced a feeling of tightness around her waist but no other sensory changes. Two months before the examination weakness began in her right hand and about the same time her right leg became stiff and "draggy" in walking. A slight change in her speech had been present since September 1938, but in the past month or two had become very nasal in quality and difficult to understand. She also began to have difficulty in swallowing, with regurgitation of fluids through the nose. All symptoms had progressed rapidly and were of a pure motor character. Her past and family history were not significant. Examination revealed an obese woman who obviously had lost considerable weight. Her speech was nasal, badly slurred and impossible to understand. Fibrillary twitching was present in the obicularis oculi muscles. Her mouth was flattened but no facial weakness could otherwise be detected. The tongue was markedly atrophic and in constant fibrillary activity. The palate elevated poorly. There was interosseous muscle atrophy and flattening of the hand muscles with some clawing. The fingers were spastic in flexion. Moderate atrophy of the muscles of the forearms was present and the inferior scapular muscles had begun to suffer atrophic changes. Fibrillary twitching was present in the hands, arms and inferior scapular muscles. Her legs were very spastic and she walked with marked extensor tonus. The tendon reflexes were very brisk in all regions but equal on both sides. There was no clonus. The abdom-

inal reflexes were absent. A bilateral Babinski sign was present.

Comment. This woman had a typical case of amyotrophic lateral sclerosis, a disease that runs a rapidly fatal course in from eighteen to thirty-six months' time. She died in July 1940. Death usually results from either aspiration bronchopneumonia or respiratory failure. The atrophic muscles are usually limited to the face, tongue, pharynx, upper extremities and shoulder girdle, the spastic condition being most pronounced in the legs.

6. *Familial Progressive Muscular Dystrophy (Without Pseudohypertrophy)*

This disease was observed in two brothers of Polish descent who are now thirty and thirty-two years of age respectively. They have two other brothers who are healthy and there are no other members of the family who have muscular disease. The disease began at about the age of fifteen and one-half years in each and has run a progressive course since that time. The boys have been under observation since April 1936.

(a) The younger brother always has been obese and this has made the weakness of his muscles a greater handicap. At the age of sixteen he noticed weakness of the muscles of his back and thighs and this slowly spread to the shoulder girdles and upper arm muscles. He has walked very little for nine years and cannot get up from the sitting position. There never has been any fibrillary twitching of the muscles or sensory changes. Atrophy of the muscles is present but masked to a considerable degree by the patient's obesity. The obesity probably is of endocrine origin. Within the past year symptoms of cardiac weakness have appeared. This may be produced by muscular dystrophy of the heart muscle.

(b) The older brother first noticed weakness in his legs while climbing steps when he was fifteen and a half years old and at the same time he began to have an aching pain in his right shoulder and in both gluteal regions. He noticed weakness and wasting away of the upper portion of his arms. This process progressed to involve the muscles of his shoulder girdle, pelvic girdle and thighs. The distal portion of the extremities has not exhibited muscular atrophy or weakness. He has great difficulty in standing up from the sitting or lying position. There never has been fibrillary twitching nor any sensory changes. His general health has been excellent. The neurological examination is normal with the exception of weakness, loss of tone and reduction of the tendon reflexes in the affected muscles, the degree of which is proportional to the amount of atrophy present. Muscle weakness is more marked on the left than on the right side. The patient has a lordosis and walks with the typical swaying gait.

A muscle biopsy was taken from the right deltoid muscle. Electrical stimulation of the muscles over this area showed a quantitative diminution to both the faradic and galvanic currents.

Histological examination of the muscle revealed a marked variation in the diameter of the muscle fibers from very small to large hypertrophic fibers. The nuclei of the muscle fibers can be seen inside the large fibers as well as in increased numbers along the margins. The inside of these fibers exhibits holes or cleavage zones. The cross striations are reduced or lost, especially in the large fibers. Some of the atrophic fibers are transformed almost entirely into fatty tissue. The interstitial connective tissue is increased in some areas and often contains masses of fat tissue.

Comment. These are typical cases of the girdle type of progressive muscular dystrophy. The disease is slowly progressive, but the course may extend over a period of twenty years or more.

7. *Pseudohypertrophic Muscular Dystrophy*

V. C., a young woman aged twenty, when thirteen years of age noticed weakness in her legs when climbing steps. This gradually progressed so that after a year she could not climb steps. She noticed some increase in size of the calf muscles and triceps on each side. There was no pain, sensory changes, muscular twitching or family history of a muscle disorder. Examination revealed weakness and atrophy of the thigh, pelvic and abdominal muscles with lordosis and a swaying gait. Pseudohypertrophy was present in the calf and triceps muscles on each side. The tendon reflexes of the upper arm were sluggish and the patellar reflexes were absent. The cranial nerves were normal.

Comment. This is an example of the Duchenne type of muscular dystrophy. The disease is more frequent in boys and usually begins earlier in life. The late onset of the disease usually is associated with a slow course and a better prognosis as to the length of life.

8. *Family Periodic Paralysis*

This disease was observed in two young women who were cousins.

The first patient, a housewife, aged twenty-two years, has been a patient at the University Hospitals of Cleveland several times since 1932. The disease manifested itself when she was thirteen years old. It began as attacks of weakness in the lower extremities which lasted from twelve to twenty-four hours and recovered without residual weakness. The attacks almost always came on at night, often after a day of exposure to cold, physical exertion or a gastric upset. As a rule the weakness began in one extremity and spread to the trunk, other extremities and neck muscles. They were accompanied by respiratory distress, nausea and occasionally vomiting. There were, however, no cranial nerve involvement, sensory or sphincteric disturbances. During the attack the patient had a flaccid paralysis or paresis of the involved muscles. On examination this was associated with absence of the tendon reflexes and a sluggish or absent response to faradic or galvanic stimulation. At times she was not able volun-

tarily to move the affected muscles. After recovery the voluntary power, the tendon reflexes and the electrical reactions were normal. A moderate residual weakness in the legs occasionally was present. In general, the patient was well developed, there was no muscular atrophy and her subcutaneous fat tissue was abundant, but she was not obese. Examination of the blood and spinal fluid was normal. The basal metabolic rate was normal.

The family history revealed a similar disease in one maternal cousin. Another maternal cousin and a great aunt probably have the same disease. The patient's mother and maternal grandmother have attacks of migraine.

The patient was observed in attacks during her hospital study. The attacks could be induced by the administration of glucose and insulin and could be terminated by the administration of potassium salts. She has been greatly benefited by potassium citrate given in a dose of five grams daily. Prostigmin was given only once during an attack, but it did not seem to alter her symptoms.

The cousin of the above patient was a single woman, twenty-six years old. Her attacks began at the age of twelve years and were identical to those of her cousin described above except that the attacks had a tendency to occur most frequently just before her menstrual period. She never had involvement of the neck muscles or respiratory difficulty. She had a dorsal scoliosis, a lumbar lordosis and some muscular atrophy of her left leg. There was reduced activity of the tendon reflexes. The patient had a diffuse thyroid enlargement. It was not definitely determined whether the scoliosis and muscular atrophy were the result of a muscular dystrophy. Her attacks also came on at night after overexertion. When the attack subsided the arms recovered first, the legs next and the back muscles last. Some of the attacks in both patients affected only the muscles of the lower extremities. Both patients had cold, clammy extremities but no other vasomotor signs.

Comment. These are both typical cases of the disease transmitted through the maternal side of the family. The family history of migraine is significant. Some patients with the disease have attacks of migraine which may alternate with the paralytic attacks. The etiology of the disease is unknown but there is good evidence that the phosphorous metabolism is not normal. Despite the resemblance, clinically, of this disease to myasthenia gravis, the patients do not seem to respond to prostigmin therapy.

9. *Amyotonia Congenita (Oppenheim's Disease)*

J. F., a ten year old girl, was examined April 24, 1938. Her parents noticed muscle weakness from the time of birth. She sat up at eight months of age but fell over easily. She was able to walk at the age of eighteen months but she fell easily and frequently. She was very clumsy with her hands. The child is intelligent and has shown no progression of her muscle weakness. Her general health has been good and there is no history of a familial muscle disorder. At the present time the child has small muscles which are difficult to palpate because of abundant subcutaneous fat. Her bones also are of delicate structure. She is slender with a rather large head and prominent eyes. The muscles of the extremities appear atrophic especially in the forearms. There is no fibrillary twitching present. The muscle tone is poor and the lower abdominal muscles bulge excessively. She has slight clawing of the fingers, a flexor contracture of the elbow joint and contracture of the tendoachilles. The tendon reflexes are absent in the arms but still present in the abdominal muscles and muscles of the lower extremities. All of the muscles are weak, especially those of the legs. The electrical test shows a quantitative reduction in the response to both the faradic and galvanic current. A biopsy of the right tibialis anticus muscle was made. Histological examination revealed very small muscle fibers resembling fetal muscle surrounded by an abundant amount of fat and connective tissue.

Comment. This represents a mild case of Oppenheim's disease which apparently is stationary. The contractures that occur in this disease are interesting considering the reduced muscle tone. Clinically this case in no way resembles the Werdnig-Hoffmann type of muscular atrophy. Improvement with muscle training and exercise may occur. The muscles histologically suggest a defective muscular development rather than a degenerative process.

10. *Myasthenia Gravis*

J. G., a colored male, aged forty-six years, entered the University Hospitals on June 20, 1939, because of weakness of two months' duration. Ten months previously he had developed a ptosis of the left eyelid which had recovered about six months before admission. Loss of weight and fatigability present for two months were accompanied for the past ten days by ptosis of the left eyelid. Later ptosis of the right eyelid and weakness of the right side of the face developed. He noticed difficulty in chewing, swallowing and weakness of the muscles of the arms and neck several days before admission. Examination of the affected muscles showed rapid fatigue and loss of power after use or by stimulation with the faradic current. There were no sensory or other significant neurologic changes. X-ray examination of the chest revealed what was interpreted as dilatation and aneurysm of the root of the aorta. Electrocardiographic tracings showed paroxysmal auricular fibrillation. Chemical studies of the body fluids all were normal. His muscular symptoms were dramatically relieved by the intramuscular injection of prostigmin. On the twelfth hospital day a severe choking spell was relieved by prostigmin. In the succeeding days these spells became more frequent in spite of prostigmin therapy. On the twentieth hospital day respira-

tory difficulty made it necessary to place the patient in the respirator. He died on the twenty-first hospital day with respiratory and cardiac failure.

Autopsy revealed a persistent thymus gland and a thymus tumor attached to the thymus gland. The ocular and other skeletal muscles showed atrophy and fibrosis of the muscle fibers and diffuse infiltration of the muscle tissues with small round cells, particularly lymphocytes. There also was a subacute diffuse myocarditis. The pituitary gland showed two small clusters of chromaphobic cells.

Comment. The presence of tumors of the thymus gland in myasthenia gravis has frequently been observed, but the disease may occur without evidence of such tumors. Lymphocytic infiltrations of the muscle fibers have not been present in all cases examined, but extensive study of all of the affected muscles seldom is possible. The observations in this case are interesting but they throw little light on the etiology of the disease.

11. *Myotonia Congenita (Thomsen's Disease)*

A white girl, nineteen years of age, was admitted to the University Hospital on October 12, 1939. The patient, as long as she can remember, has experienced difficulty in the initiation of voluntary muscle movements. She noticed this especially in climbing steps and grasping with the hands. After a voluntary act is repeated for a short time, the muscle movement and strength become easier. She can climb the second flight of steps without difficulty. She had great difficulty in releasing a grasp or in opening the mouth after biting. She does not know any details of her family history, but her older sister has a milder degree of the same muscular disorder.

Physically the patient is well developed, her muscles are bulky and would appear to be very strong. Her general medical and neurologic examinations are normal except for the muscular system. All of her tendon reflexes are sluggish or absent except for the extensors of the forearm and Achilles reflexes. She has no pathological reflexes. Her muscles show a slow sustained contraction and relaxation to mechanical, voluntary or faradic stimulation. This tends to become normal after twenty-five or more contractions. The characteristic myotonic muscle reaction to various types of stimulation is almost completely abolished by quinine given by mouth.

Laboratory tests of the blood and urine are entirely normal.

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Electrical Testing of Muscles and Nerves, and Determination of Its Value in Prognosis and Treatment

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There exists a varied opinion among medical men as to the value of electrical testing of muscles and nerves. This controversial attitude is based, I believe, upon uncertainties which arise when such tests are performed. The reason for these uncertainties primarily is due to imperfections in technic and to certain human errors to which such tests are liable. With all these drawbacks, electrical testing of muscles or nerves is fundamentally sound, reliable and of proven value.

(1) The value of electrical muscle and nerve tests rests upon the fact that they are based upon sound reasoning. Certain consistent physiological reactions occur when healthy nerves and muscles are excited. Likewise, in the presence of certain pathologies, abnormal reactions consistently are in evidence.

(2) In electrical nerve and muscle studies, we often are able to distinguish definitely between organic and functional conditions affecting the motor mechanism of the body.

(3) In these methods we also have at hand an additional means of localizing lesions concerned in impaired motor voluntary mechanisms. Distinctions between lesions of upper and lower motor neurons, and interruptions in continuity of the reflex arc can be determined and located. Certain other characteristic pathognomonic muscular reactions are brought out by these tests.

(4) Electrical muscle and nerve tests, when considered in relation to other subjective and objective findings, assist in determination of prognosis in certain pathologic conditions of muscles and nerves.

(5) Likewise, once determined, muscle and nerve gradations serve as a basis for estimation of improvement in pathological conditions when repeated at intervals.

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The rationale for the use of electrical testing in motor disabilities is based upon the physiologic responses which normally occur when muscles and nerves are stimulated electrically. In order to secure these responses, individual nerve elements must be healthy and there must not be present any disruption in physical continuity. Motor responses peripherally may be occasioned by electrical excitation of the cerebral centers, but the inclusion of these centers in excitation of motor contractions is not necessary. It is this phenomenon which is the basis for differentiation between lesions in the upper and lower motor neurons.

In electrical nerve testing we are concerned in two factors: What are those elements which must be present in order to secure a normal reaction? What constitutes a normal reaction to the various forms of electrical stimulation?

There is no need at this point to review the anatomy of the reflex arc and associated fibers connecting various levels of the spinal cord. Any interference in continuity in the posterior columns, posterior nerve roots, spinocerebellar tracts and cerebellum will occasion a loss of muscular tonus anatomically related to the distribution of impulses originating in or passing over these structures.

Increased muscle tonus presents itself (1) where normal inhibition, continuously being exerted through the pyramidal tracts, is for any reason diminished; and (2) in irritative lesions of the sensory component of the reflex arc.

Voluntary movement will be interfered with if there is interference with continuity anywhere between the higher centers in the cerebrum and the motor end plate and muscle itself.

Electrical nerve tests are brought to bear in cases where normal voluntary movement cannot be initiated. When voluntary movements are possible, we can best resort to manual muscle tests for our evaluations. The

maximum contraction is obtainable at certain anatomical points where a nerve trunk or a nerve to a definite muscle is most easily accessible. This is known as the motor or nerve point. A normal response to electrical stimulation of a muscle either directly or through its nerve fiber is a definite type of contraction which cannot be confused with a subnormal or pathological response. A normal reaction to faradic stimulation consists of a prompt reaction immediately the current is applied. This contraction continues as a tetanic contraction so long as the current is flowing. A normal reaction to galvanic stimulation constitutes a sharp, lightening-like contraction which is greatest at the negative pole when the current is closed. This is designated as cathodal closing contraction (KCC). The strength of these contractions grades in the order, KCC, > ACC, > AOC, > KOC. In the case of galvanic current, the initial contraction immediately relaxes and another contraction is obtained at the time the break in the current is made. A minimal amount of electricity is required for the production of normal contractions over motor points. The amount of this current is individual in each case.

In determining the presence of pathological responses, we consider the following:

(1) Promptness of the response. A pathologic response is slow in appearance; that is, more current must accumulate to incur contraction.

(2) Nature of the response. A pathologic response grows slowly, often with a worm-like quivering movement, to attain a maximum.

(3) Quantity of current required. A pathologic response is attained only after inflow of greater quantity of electricity. Response first occurs at higher meter readings.

(4) Is there response to faradic current? A definite time interval exists before response occurs to electrical excitation. This is known as chronaxia. This interval in a healthy nerve is 1/1500 of a second. A degenerated muscle may require as long as 1/50 of a second before contraction starts. With faradic current, the "break" of the secondary current which produces the muscular response is present for a very short duration of time—1/1000 of a second. The frequency of the tetanic interruptions—80-100 per second—do not concern us in muscle-nerve testing. Hence, we find that very early in degeneration of a nerve, faradic response is not obtainable due to this short interval of stimulation. In degenerating nerves or muscles galvanic responses still can be elicited long after faradic response cannot be obtained.

(5) Is polar inversion demonstrable? A pathologic state of the nerves will result in a relative diminution of the normally increased response obtained at the cathodal closing contraction when using the galvanic current. KCC may equal or be less than ACC.

(6) Is the point of maximum excitability where anticipated? In pathological conditions the motor point of a muscle may shift with increase in pathological change in a direction toward its tendon. Motor points of nerves may disappear. In a rapidly occurring reaction of degeneration, this phenomenon is readily noted.

In diagnosis the oldest and simplest methods of galvanic and faradic are in most universal use. Prognosis may be determined by these tests, and follow-up may be carried out.

Measurements by these methods are not easily made and, consequently, for accuracy in following up cases where impairment exists in peripheral nerve lesions, condenser sets often are used. The galvanic current is used. The principle rests upon the fact that when a condenser is discharged, through a constant resistance, the time of discharge varies according to the capacity of the condenser; that is, a condenser cannot discharge until its capacity is reached. The greater the capacity, the longer the discharge will be. It has been noted that as degeneration in muscle occurs, the longer the stimulus must be applied to secure a response. So, with varying condenser capacities, a numerical equation can be utilized to register varying degrees of contractability (degeneration or regeneration). A series of twelve condensers, ranging from 0.01 microfarad, which discharges in 1/24,000 of a second to 2/ microfarad, which takes the relatively long interval of 1/200 of a second to produce a contraction, are utilized. A large variety of resistance can be interposed in the current and changes in excitability noted.

The disadvantages of this method are the time necessary and the fact that when reaction of degeneration is present, often no reaction is obtainable with a condenser set; whereas by increasing the quantity of cur-

rent by the ordinary galvanic method, responses could be obtained.

Chart showing gradation of steps in condenser resistances and time element involved in a condenser set:

	Capacity Microfarads	Discharge duration Second
1	0.01	1/24,000
2	0.02	1/16,000
3	0.05	1/8,000
4	0.06	1/6,000
5	0.08	1/4,800
6	0.12	1/3,200
7	0.25	1/1,600
8	0.33	1/1,200
9	0.50	1/800
10	0.66	1/600
11	1.00	1/400
12	2.00	1/200

A new method employing the so-called "chronaximeter apparatus" represents an improved piece of equipment for muscle nerve testing which permits of mathematical precision in recording of findings.

This method owes its existence to certain determinations of Lapicque and Bourguignon. Their investigations determined that if a muscle or nerve is stimulated by electrical current, the current must reach a certain intensity before any contraction will occur. Also, this impulse must be in existence for a certain period before a response will take place; this period is known as "chronaxia." Chronaxia is the reciprocal of excitability. With diminished excitability of a muscle, increased chronaxia time is present.

By the chronaxia method, a *definite* measured amount of current, applicable to each muscle to be tested, is utilized. The variable factor by which the various reactions are measured is the time factor. This time factor is measured in units called "sigmas." A sigma is arbitrarily 1/1000 of a second. The galvanic threshold, that is, the smallest amount of galvanic current which will produce muscular response at the motor point, is measured. This galvanic threshold is called the "rheobase"—the product of volts times milliamperes.*

Certain relationships normally exist in chronaxia of normal muscles. In health, all skeletal muscles with intact nerves have chronaxias ranging between .06 sigma and .70 sigma (less than 1.0 sigma). The lowest chronaxia of any muscle is found at its true motor point. Flexor chronaxia usually is one-half that of corresponding extensors. Chronaxia increases toward periphery and is the same for a muscle as its nerve, but if the nerve is diseased or injured, the muscle supplied by this nerve shows an increase in chronaxia (2.0 or more).

In disease, chronaxia may become twenty to one hundred times normal. This is a means of determining a complete or partial reaction of degeneration. In disease of anterior horn cells, if a sufficient number of cells are affected, the chronaxia of the muscles supplied by the affected fibers will be increased. Chronaxia also can be utilized in testing of sensory nerve impairment. Similar increase in time intervals occur. Likewise, repair progress can be exquisitely followed.

TABLE OF RANDOM NORMAL CHRONAXIAS

	Average Chronaxia	Average Rheobase	Chronaxia Range
Latissimus dorsi	.18	105 V.	.14-.23
Teres major	.23	120 V.	.18-.29
Trapezius	.18	140 V.	.10-.29
Ext. pollicis longus	.31	95 V.	.27-.40
Flex. pollicis longus	.32	95 V.	.27-.40
Biceps femoris	.30	170 V.	.20-.45

(From Licht)

Although the detail of muscle nerve testing already is familiar, I would like to stress a few points in the technic where special care should be taken:

The apparatus should be in good working order. If a battery apparatus for galvanic testing is used, at least 22:5 volt B battery should be employed, perferably two such batteries. The galvanic apparatus must include a fine control mechanism, a milliammeter and a polarity switch. All cords must be in good condition and the cord tips free from erosion. Before using the machine, it must be tested, preferably on the one doing the testing. The purpose of muscle nerve testing has been impressed on the patient and we must avoid shaking his confidence by any failure on the part of the equipment. Also, for the same reason, we must avoid unnecessary shocks throughout the procedure.

Before starting a muscle nerve test, the tester should have been advised as to the ex-

*Law of electrical muscle and nerve stimulation first formulated by Dubois Reymond: The intensity of a stimulus and the subsequent muscular contractions are directly proportional to the magnitude and change in current strength (VxA), or in the presence of the same current strength, the intensity of a stimulus is proportional to the rate of fluctuation (rapidity with which it occurs).

tent and apparent purpose for which the test is to be made.

The parts to be tested must be in good light. We are trying to observe unusual contractions and good light is essential. In placing the patient, be sure to have the muscles being tested in a position where there is relaxation and where the contraction does not have to work against gravity. The indifferent electrode should be placed, preferably, proximal to the parts tested and in the center of the spine. This is not essential, but desirable, and such habits tend to consistency in technic. This pad and also the active motor point electrode should be thoroughly soaked in saline and kept well moistened throughout the test period. The exciting electrode must be very small in size and the make and break arrangement such that little pressure is necessary for firm contact. There must be no erosion at point of contact. In making contact, pressure should not cause a movement of the integument with which the saline tip is in contact. Such movement easily can be mistaken for a muscular contraction. A good standard chart for determining motor points should be kept constantly in view. Two persons are necessary to do a satisfactory muscle nerve test. The meter must be carefully watched and the reactions charted at each point before proceeding to the next. Note promptness and character of the response, current required to produce minimal contractions, and reactions to both negative and positive stimulation with the galvanic current. It is well, before testing the affected muscle, to test out quantity of current required on a healthy muscle corresponding to the one being tested, if such is possible.

If, in testing with galvanic current, a large amount of current is required and no contraction is evidenced until a broad spreading contraction over multiple areas is observed, it is best to test the individual muscle by the polar method. A small pad is placed near the end of the muscle to be tested and the exciting electrode is placed peripherally on the same muscle. Presence of edema will interfere with muscle nerve testing. If edema is present, attempt to remove it, and keep the part elevated during the test period. Extreme obesity will require greater quantities of current.

There are several individually peculiar reactions to electrical stimulation which are important to know. These are the myatonic reaction, the myotonic reaction, and the myasthenic reaction (Jolly test).

Myatonic Reaction: The abnormal reaction consists of a delayed response to faradic excitation. Strongest faradic responses can be produced without pain. No galvanic excitability is present. Found in Oppenheim's disease.

Myotonic Reaction: Often a single faradic shock produces tetany lasting for 5 to 30 seconds. No increased faradic excitability. Galvanic stimulation with even 1 ma. may cause muscular contraction and well-formed wave-like contraction. KCC and ACC are equally easy to obtain. No quantitative changes are present.

Myasthenic Reaction (Jolly Test): In this test, faradic current is used. At first we get a strong faradic response. Contractions are repeated at about one second intervals with progressive diminution in response being noted, until finally no reaction is observed with the strongest current. Some volition, however, remains. The faradic excitability recovers in a few minutes but if the test is repeated, reaction will diminish quicker than before. This is the characteristic response found in myasthenia gravis. Galvanic responses normal throughout this disease.

A few words about reaction of degeneration (R.D.): This is a pathologic response of muscle to galvanic current, characterized by sluggishness, wave contraction with tendency to persist after exciting current is removed. This form of contraction usually is associated with other abnormalities of electrical reaction in nerve and muscle: (1) quantitative change, (2) qualitative change, and (3) polar change. These have already been explained.

The degree of R.D. depends upon the extent and progress of the degenerative atrophy in nerves and muscles.

(1) *Mild Degree:* 5-7 days after severe injury, a diminished response of nerve to galvanic and faradic current, and, likewise, diminished contraction of muscle to faradic current. By the end of two or three weeks no reactions to faradic are demonstrable.

For several days after injury galvanic excitability declines, but by the end of the second week, response to galvanic increases but contraction is sluggish and wavy. Anodal contractions gradually assume greater proportions until polar inversion occurs. These changes are paralleled by degenerative atrophy in nerve and muscle. After four to eight weeks, when some active movement already is notable, the electrical reactions are obtainable in the direct opposite sequence as they disappeared (reaction of regeneration). Total—about eight to ten weeks.

(2) *Medium Degree of R.D.:* Similar to mild degree, but more severe. Voluntary movement reappears in the fourth to eighth month or later, and regeneration occurs with complete restoration of normal electrical conditions in from six months to a year thereafter. Total—12 to 18 months.

(3) *Severe Degree of R.D. (Total R.D.):* Regeneration does not occur. Irreparable atrophy with proliferation of connective tissue occurs. Polar inversion is complete by about the third month. Progressively greater currents are required to produce contractions with galvanic current. Finally KCC disappears, then ACC disappears and all electric excitability of muscle and nerve is lost permanently. This may extend over a period of two years.

In general, if, following an injury, ten days have elapsed and no R.D. is present, we may anticipate recovery in from two to four weeks. Presence of R.D. means we must allow an appreciable time for recovery. If a lower motor neuron injury is not arrested, full atrophy and R.D. will occur.

In organic spinal affections and peripheral toxic neuritis, prognosis always is guarded. R.D. in poliomyelitis is irregular, and no sensory disturbances are present. R.D. in peripheral neuritis is of regular distribution and associated with sensory disturbances. Careful regard for the origin of nerve supply to muscles serves as a means of definitely localizing lesions in anterior horn disease and in lower motor neuron affections.

This presentation does not include the interpretations to be drawn diagnostically through the results of these tests. The diagnosis is dependent upon many factors such as history, subjective symptoms, physical findings, laboratory reports, course of disease and certain psychological aspects. Muscle nerve tests serve as an adjunct to these more important factors.

Assistance in localization and determination of extent of lesions is given by electric muscle nerve testing. It is not in the province of the physical therapy technician to bother him- or herself with these medical aspects, but it is the duty of the technician in electric muscle and nerve testing to assist the physician in performing the tests. If the technician is employed in an institution doing a considerable amount of work with poliomyelitis, neurology or traumatic surgery, he or she may be given greater responsibility along these lines, if the physician in charge so desires.

The real, valuable contribution the physical therapy technician can offer with muscle nerve testing is in refinement of technic and the repetition of tests routinely, after diagnosis has been determined and original tabulations as to extent of the lesion have been recorded.

Juvenile Asthma

Ina M. Richter, M. D.

Asthma is only one of the more dramatic manifestations of the so-called allergic diseases. The other types of more common allergic conditions are eczema, urticaria, hay fever and angio-neurotic edema. The term "allergy" is difficult to define but indicates a certain specific sensitivity or idiosyncrasy of an individual to a foreign protein such as may be contained in certain foods, epidermals (hair, feathers, powders, etc.) or pollens.

The exact cause or mode of action of allergens on a susceptible individual still is poorly understood. Many theories have been advanced but as these are of academic interest only, let us omit them in the present discussion. Three main factors have a bearing on the development of the condition. The first of these is the reaction to a specific allergen such as egg white, chicken feathers or ragweed pollen. The second important factor is climatic or atmospheric, the incidence and severity of the attack varying with the locality, season of the year and state of atmospheric conditions. The third factor is a psychogenic one and depends on the vagosympathetic response of the individual and his interaction with those about him.

The discovery of how many and which of these factors is involved, and to what extent, is the problem of the physician and often a very difficult one. The history must be gone

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into in great detail, as it requires the qualifications of a detective as well as those of a physician to determine to what extent each of these factors is involved. It is important to know what the child eats and whether he partakes of a certain food each day or only occasionally, with what substances he daily comes in contact and what pollinating plants are growing in his vicinity. Do other members of the family have the same or similar conditions? Is the condition seasonal or perennial? Do the attacks occur at night? Getting a complete history is a time-consuming occupation and requires complete cooperation on the part of the child and his parents. The actual physical examination outside of the individual attack does not reveal very much. Every layman recognizes the typical attack of eczema in a baby, of asthma in the older child and of hay fever or urticaria. Long standing asthma produces a particular habitus in which the nares look pinched, the shoulders hunched up and the neck shortened. The running nose and red eyes of the hay fever victim are readily recognized. But there are many milder forms which are not readily recognized. Examples of such are the repeated "colds" which actually are an allergic phenomenon. The appearance of the nasal mucous membrane and a smear from the nasal secretions often will differentiate the conditions. The more or less constant cough of the small child, especially if it has a "croupy" quality, is an allergic phenomenon and not a cold or bronchitis. There are many other minor allergic conditions which, if recognized early, can be prevented from progressing to a more serious form of the disease. The asthmatic child as a rule, except during an attack, has as good a vital capacity as the average child of the same build, age and sex. We test all our children with the spirometer once a month.

After this more or less elaborate history has been taken and the less important physical findings have been recorded, one can begin testing the child for specific allergens. There are two methods of testing: the scratch or dermal, and the intracutaneous or endermal. In my opinion a combination of the two methods is advisable. One should first make scratch tests of extracts of all suspected materials and follow these with intracutaneous tests of those which are frankly negative to scratch testing. In this way one is quite sure to confirm the diagnosis made by a very careful history.

Unless both the parent and attending physician are willing to devote a great deal of time and thought to the causes, diagnosis and treatment of the patient, the condition is almost hopeless from the point of view of prognosis. In a well-developed case of juvenile asthma, all treatment will fail unless it takes into account and adjusts the psychogenic and environmental factors as well as the administration of specific allergens. One can discover the specific allergens and hyposensitize the patient by the administration of extract in gradually increasing doses and have the entire treatment fail if he does not take into account the child's environment and his relation to those in attendance upon him. An attack of asthma in a small child is a terrifying experience for a mother and calls for the administration of adrenalin as much to relieve the fears of the mother as the difficult breathing of the child. Repeated attacks and repeated injections of adrenalin soon engender a fear complex in the child. Both mother and child becomes exhausted, and a separation of the two is indicated. Such a separation gives the mother physical rest. The child, in the custody of those who understand his condition, again builds up confidence and becomes normal. The environment to which he is removed should be as nearly that of the average child as can be effected under the circumstances. Many attacks of asthma also are precipitated by sudden changes of temperature, a sudden drop in barometric pressure or a protracted period of either very dry or very wet weather. The adaptation of the asthmatic child to changes in atmospheric conditions is poor.

Whenever a child has become a confirmed asthmatic and the proper emotional adjustments cannot be made in his own home, it is best to send him away to a school in a part of the country where the climate is equable. In such an environment the attacks become much less frequent or even nonexistent, and the child gains in weight and strength (because he always loses three to four pounds during an attack.) His life is a happy one because his play and lessons are uninterrupted. While in attendance at such a school, the physician or nurse can hyposensitize the child, and the frequent and exhausting trips to the physician's office can be avoided. It often takes several years of hyposensitization and building up of physical and emotional strength before the child is able to return to his original environment.

The Physiotherapy Review

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The proposed program of the American Physiotherapy Association for 1941 is being planned in a somewhat different vein than heretofore. The National Executive Committee asks that each member consider it carefully and give all possible support.

A number of chapters found that a series of discussions on one subject contributed greatly to each individual from the physical therapist's point of view. We are growing into so large a body that new methods for developing our skill and knowledge appear to be in order. For this reason, a conference type of national meeting is to be inaugurated. Those attending the conference will take their choice of a number of discussion groups that will extensively consider a particular field throughout the meeting. It may be that the Executive Committee will have to ask that those participating in the conference indicate, prior to the conference, the subject they wish to study to prevent any one group from becoming too large.

The meeting is being planned to take place at Asilomar, a resort hotel on the famed Monterey Bay. Here where cottages, fireplaces and lounge rooms invite group gatherings are found beautiful classrooms, exhibit rooms and a large auditorium for more formal discussions. In addition, opportunities for every form of sport beckon one into a most glorious out-of-doors.

Preceding this meeting at Asilomar will be a new venture of great importance. Graduate study on a university basis and leading to advanced degrees was instigated at Stanford University at the beginning of 1940. It gained excellent support immediately from physical therapists in the region. Your Executive Committee feels that this can be developed on a national scale. To that end, it has been voted to spend a sum of money each year for the next two years to foster the development of graduate courses in the region in which the annual conference is to be held. Dr. Herman Chor, of Northwestern University Medical School, is to give courses in a month's short course this year, in connection with Stanford University, just preceding the convention. Tentative subjects are "Psychology of the Invalid and Handicapped" and "Muscle in Relation to Physical Therapy." Other courses offered will be "Advanced Kinesiology," "Therapeutic Gymnastics," and "Study of a Special Problem in Physical Therapy."

During the conference itself, additional discussion groups will be organized in electrotherapy, problems of crippled children's schools, physical therapy schools and muscle testing. Any suggestions regarding these or other subjects which should be included will be welcomed by your committee.

It is greatly hoped that every member who can plan the time between June 19th and July 18th as his or her vacation and study period will come to play and study in Northern California. Here we have for your play time all the strange nooks and crannies of justly thrilling San Francisco and the Bay region. Sequoia National Park and Yosemite are but a scant half day's drive away. The famous Seventeen Mile Drive along the out-jutting Monterey and Carmel Peninsula lies at the door of Asilomar. Del Monte and Pebble Beach, the playground of Hollywood and society; Point Lobos and Carmel, the mecca of artists and writers, lie along this drive. On this stretch of coast are found the fishing fleets of Monterey Bay, the world's most ancient living trees, the old missions established by plodding padres, and "the only place in the world where piny mountains meet snow white sand dunes on the blue Pacific." Asilomar is air-conditioned by nature for summer study and play, never too hot, never too cold. In this splendid setting is found another great advantage: living quarters and splendid meals are available at prices ranging from $16.00 to $25.00 for the five days of the conference. These very moderate rates and the famed hospitality at Asilomar should bring each and every one of you to the 1941 conference.

Red Cross Enrollment

As stated in our news letter of September 21, 1940, Physical Therapy Aides selected from the list compiled by the American Red Cross to serve with the Medical Department of the U. S. Army during the emergency will be classified as civilian employees and, as such, they come under the provisions of the United States Employees' Compensation Commission.

In order to clarify the many questions which have arisen about this protection, the Executive Committee of the American Physiotherapy Association has obtained permission to publish the leaflet entitled "Right to Compensation for Personal Injuries of Civil Employees of the United States Under Federal Compensation Act of September 7, 1916, as Amended," which reads as follows:

BENEFITS PROVIDED BY LAW

If a civil employee of the United States sustains an injury "while in the performance of his duty," he is entitled to—

1. Medical, Surgical, and Hospital Service and Supplies, and Transportation if Necessary to Secure Them.

Treatment must be obtained from United States medical officers and hospitals if practicable; if these are not available, then by physicians and hospitals designated by the Compensation Commission, a list of which will be found in the hands of the official superior or head of the establishment. Where there is no designated physician or hospital, or United States medical officer or hospital, any reputable physician licensed to practice medicine, or any hospital, may be employed.

2. Money Benefits While Disabled for Work.

Beginning on the fourth day of disability, or if leave with pay is taken, then on the fourth day after pay stops, and continuing throughout the entire period of disability.

If totally disabled, benefits to be at rate of two-thirds of the monthly pay (including value of subsistence and quarters, if furnished), but not more than $116.66 nor less than $58.33 per month, except when the monthly pay is less than $58.33, in which case the monthly compensation shall be the full amount of the monthly pay. If partially disabled, benefits to be at rate of two-thirds of the loss of wage-earning capacity caused by the injury. If loss of wage-earning capacity is permanent, compensation is payable till death.

3. Burial Expenses in Case of Death.

Burial expenses not exceeding $200, and transportation of body of resident of United States dying away from home station, if relatives desire it.

4. Money Benefits in Case of Death.

Total compensation can not exceed two-thirds of monthly pay of deceased, which monthly pay for computing compensation shall be considered to be not more than $175 nor less than $87.50, but the monthly compensation cannot exceed the monthly pay.

To widow or wholly dependent widower, 35 per cent of monthly pay of deceased employee until death or remarriage; and, in addition, for each child under 18, 10 per cent of monthly pay until death, marriage, or reaching the age of 18.

To one child under 18, if there is no widow or dependent widower, 25 per cent of monthly pay.

To each additional child under 18, 10 per cent—

To be divided among the children equally.

To be paid until death, marriage, or reaching age of 18, to child's guardian.

Also compensation to parents, brothers, sisters, grandparents, and grandchildren, for eight years, or until death, marriage, or reaching the age of 18, if dependent on deceased.

No compensation is payable if the injury was caused by—

(a) Willful misconduct.
(b) Intoxication.
(c) Intention to bring about injury.

WHAT TO DO WHEN INJURED

1. Report the injury to your immediate official superior without delay.

This is important to protect you in case of dispute. Also make note of the names and addresses of those witnessing the injury.

2. Then secure first-aid treatment. Do not neglect the small injuries.

Sometimes blood poisoning or permanent disability or death results from neglecting a slight injury.

3. Treatment by the medical officer or dispensary of your establishment, or if there is none, by the physician or hospital provided by the Compensation Commission to treat injuries, will cost you nothing.

Your official superior has a list of such physicians and hospitals, and will give you an order for treatment.

4. Claim should be made promptly. Unless made within one year Commission is without jurisdiction.

The blank form for this purpose may be obtained from your official superior.

5. An injured employee is entitled to have any claim for payment of compensation or medical or hospital service on account of an injury which he believes was sustained while in the performance of duty on or after September 7, 1916, passed upon by the Compensation Commission.

If in doubt about your rights under the compensation law, write to the United States Employees' Compensation Commission, Washington, D. C.

The National Foundation for Infantile Paralysis announces the publication of a pamphlet on "Nursing Care of Patients with Infantile Paralysis" by Jessie L. Stevenson, R. N., Consultant in Orthopedic Nursing, National Organization for Public Health Nursing. This pamphlet, illustrated by line drawings, was prepared by the National Organization for Public Health Nursing for The National Foundation for Infantile Paralysis as a part of a project in orthopedic nursing sponsored by the Foundation. It is intended to assist the public health nurse and others responsible for home care of patients with infantile paralysis in and following an epidemic. Copies are available free upon request from The National Foundation for Infantile Paralysis, 120 Broadway, New York, New York, Basil O'Connor, President.

Two booklets entitled "The Use of the Respirator in Poliomyelitis" and "Respirators—Locations and Owners" also will be furnished on request.

Correction

In the September-October 1940 issue, page 307, under "Recent Progress in Physical Therapy" by Richard Kovacs, M. D., line 3 which reads "air heated up to 103 F." should read "air heated up to 130 F."

Mr. Howard A. Carter, Secretary of the Council on Physical Therapy of the American Medical Association, was presented with the First Award for the "greatest value to medicine in the field of otolaryngology" for his exhibit at the recent Annual Session of the American Academy of Ophthalmology and Otolaryngology in Cleveland, October 7 to 11, 1940.

Georgia Chapter

Dr. J. H. Kite, Chief Surgeon of Scottish Rite Hospital, Decatur, Georgia, was the principal speaker at a meeting held by the Georgia Chapter of the American Physiotherapy Association at the Warm Springs Foundation, October 18. His lecture concerning many orthopedic conditions and methods of treatment was interestingly illustrated by his own moving pictures of hospital patients. Dr. J. H. Gaston of Columbus, Georgia, also spoke. Dr. C. E. Irwin, Chief Surgeon at the Warm Springs Foundation, introduced the speakers. The meeting was attended by visitors from Decatur and members of the Association from Atlanta and the staff at the Foundation.

Northern California Chapter

The Northern California Chapter held its first meeting of the year on September 28, 1940, with the national officers as the guests of honor.

A large cake bearing the inscription "Greetings to the National Officers" as well as the national insignia in blue and gold served as an attractive centerpiece on the supper table.

The chapter members expressed their intention to cooperate with the national officers during their two years of service, and to bear out these intentions, presented the officers with gifts to aid them in their various duties —Miss Worthingham, a tiny bell with which to call executive committee meetings to order; the vice presidents, Miss Young and Miss Rice, gargantuan pencils; a slate to Miss Anderson, in order that she might more easily take the minutes, and a bank in the form of a globe, to Miss Wallace, to assist her in her duties as treasurer.

Index to Current Literature

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ABSTRACTS

John S. Coulter, M.D.

Therapeutic Advances in Vasomotor Rhinitis and Bronchial Asthma

J. A. Haiman, M.D. In Arch. P. T., Aug. 1940.

Much has been written about ionization of the nose for vasomotor rhinitis. This form of treatment has been practiced for twenty years. The procedure employed in the nose is a relatively simple one and no elaborate equipment is required.

Much has also been written about electrocoagulation of the hypertrophied inferior and middle turbinates of the nose. This procedure is done by first cocainizing the anterior portion of the turbinates. Then the biterminal nasal electrode is introduced in the turbinate and carried back all the way to the posterior tip. In nasal polyps, it usually takes from six to ten applications for their complete removal.

Haiman believes that ultraviolet radiation has a very beneficial effect upon the nasal and pharyngeal mucosa. The average maximum exposure is a minute and a half. Longer exposures will produce marked burning of the sensitive nasal and pharyngeal membranes. It also is highly important to keep the generator checked up every three to six months to be sure that one is getting adequate ultraviolet dosage.

Infra-red irradiation is a great aid where one is suffering from an intense sinus headache. In fact, Haiman states that no other method will as readily relieve an acute sinus headache. An exposure from three to fifteen minutes may be given without any harmful effects to the eyes or skin.

Diet plays an important role in these cases. The withdrawal of carbohydrates, sweets, fats and condiments is very essential. Topical medication is used to give immediate relief for nasal congestion. The most popular drug today is a neosynephrine (1 per cent) solution. It is important to administer calcium intravenously.

Physical Therapy in Arthritis with Special Reference to Home Treatment

Frank H. Krusen, M. D. In J.A.M.A., Aug. 24, 1940.

Although physical treatment plays a very important part in the management of many types of arthritis, and although its employment has been enthusiastically advocated by many authorities on rheumatic diseases, nevertheless physical therapy should never be used to the exclusion of other therapeutic procedures.

Whereas it is possible to bring great benefit to the patient who has arthritis by the utilization of certain simple physical measures as a part of the home treatment, such procedures can be used to greatest advantage only when they are made a part of a well planned program of general treatment.

The classification employed in the present discussion is as follows:

Thermal Agents.—In the management of arthritis, local or general application of heat may be of great value. Heat is most readily applied in the patient's own home by means of some simple device, such as a homemade baker, clamp lamps, electric heating pads or hot paraffin packs. If electricity is unavailable in the patient's home, local applications of ordinary hot paraffin may be employed as a substitute for the simple radiant heat devices. The lower pan of a double boiler is filled with water and cakes of paraffin are placed in the upper pan. The paraffin is then melted and permitted to cool until a thin film has formed on its surface. At this time, when the paraffin is at its low melting point, it may be painted over the involved arthritic joint or other region with an ordinary paint brush or swab of linen on a stick. About twelve coats should be applied in rapid succession and this thick layer of paraffin is allowed to remain in place for from thirty to sixty minutes.

Whirlpool Baths.—A simple whirlpool bath can be constructed very cheaply for home use. The Council on Physical Therapy has prepared specifications for the construction of this device.

Heliotherapy.—Occasionally patients with arthritis who are in poor general physical condition, undernourished and suffering from secondary anemia may be benefited by a series of exposures to natural or artificial sunlight. If climate and home conditions permit exposure of the nude patient to sunlight, the best procedure is the method of insolation described by Rollier.

Tub Baths.—It has been found that in certain cases of atrophic arthritis very mild febrile reactions may tend to control an exacerbation of the disease. It is entirely possible, under proper medical supervision, to obtain exactly the same type of febrile reaction at home by placing the patient in his own bathtub. The temperature of the water may be varied between 98 and 105 F. and the duration may vary from ten to forty-five minutes.

Cold Baths.—By proper timing and graduation of cold baths or showers, the arthritic patient who is sensitive to cold may be gradually made more tolerant to it. The patient who has arthritis and who is frequently abnormally sensitive to external cold sometimes may be benefited by the so-called hardening treatment which consists of repeated applications of brief cold baths or showers.

Contrast Baths.—The patient should be told to obtain two buckets or pans of proper size and shape for immersion of the feet or hands. One container should be filled with hot water at comfortable tolerance, from 105 to 110 F.; the other container should be filled with cool tap water, from 60 to 65 F. With patients at the Mayo Clinic, the best routine has seemed to be one in which five minutes of heat and two minutes of cold or four minutes of heat and one minute of cold were employed. One should always start and end with immersion in hot water to obtain the best vascular response.

Massage should not be employed if there is acute pain on movement or if there is a marked rise of temperature in the region of the affected joint. As a rule, direct massage over the joint is to be avoided, although extremely light stroking may at times be employed to relieve pain. It has been found that when, for economic or other reasons, a trained masseuse is not available in the patient's home, a skilled technician can instruct a member of the family in a few harmless simple massage strokes, which may be used either in lieu of or to augment professional treatments.

Manipulation.—Because every effort should be made to prevent the occurrence of contractures, especially in atrophic arthritis, attempts at mobilization are an essential part of the treatment. Manipulation, even in the form of relaxed movement, should not be employed as long as there is any acute pain on movement. Joints which are mildly sensitive, however, may be mobilized gently, attempts being made to carry them slowly and rhythmically, only once or twice daily, through the fullest possible range in each direction. Above all, the joint

should never be jerked or pulled violently, but slow, graduated pressure should be applied up to a point just short of producing severe pain. If there is an increase in joint pain following such relaxed movement which persists until the following day, it will be known that the manipulation has been too rigorous.

Splints.—The chief deformities to be sought for and prevented are adducted shoulders, thoracic kyphosis and fixation of the thorax, flexion of the elbows and especially of the wrists and knees as well as loss of abduction of the hips and foot drop. Particular pains should be taken to avoid the constant use of pillows beneath the knees and under the head.

Shoes.—The patient who has arthritis may habitually walk around the home for hours at a time in shapeless and loose bedroom slippers. As a matter of fact, a well fitting, stiff shanked shoe is much more comfortable; and in many instances if a soft pad is placed under the instep to support the longitudinal arch of the foot and a metatarsal bar (a raised leather piece on the external sole just back of the anterior arch) employed to support the anterior arch, and if occasionally a soft heel pad or wedge is placed under the heel, even the arthritic patient with painful joints may walk with considerable comfort.

Exercise.—The usual scheme in mobilizing a joint which has been the seat of acute inflammation in arthritis is first to employ relaxed movements; second, active assistive exercises, and at the earliest possible moment to change to active voluntary exercises. One slow movement through full range is preferable to many "wiggles" through partial range. Weight bearing should be avoided until it can be well tolerated. Knees should be well straightened before walking is permitted. Walking usually should be started in a "walker," which consists of a frame on wheels which supports most of the patient's weight on the axilla and elbows.

Postural Exercises.—An important point in the management of the patient with chronic arthritis is to remove mechanical handicaps by maintaining the best possible alinement of joints. Postural exercises may be valuable for this purpose.

Underwater Exercises.—Occasionally underwater exercises may be of considerable value in the reestablishment of function for patients with atrophic arthritis. Such exercises are particularly useful when many joints are involved. It is best to administer them in a Hubbard tank and occasionally these tanks are constructed for home use.

Occupational Therapy.—The home use of occupational therapy may be extremely useful in rehabilitating patients who have chronic arthritis and many simple devices commonly found in the home may be employed to advantage to strengthen muscles and increase motion in joints by providing certain exercises as part of the occupation.

Rest.—In any case of arthritis, rest is of cardinal importance during the stage of acute inflammation. It should be remembered, however, that such rest should be permitted only with the joint held in a position to prevent contracture and deformity. Furthermore, rest should not be continued indefinitely.

Muscle Lesions Simulating Visceral Disease

J. B. Harman, M.D., and R. H. Young. In Lancet, No. 6095, p. 1113, June 22, 1940.

It is common knowledge that disease of structures of the back, such as Pott's disease, carcinomatous deposits in the spine, and osteo-arthritis, may cause pain in the abdomen, because the disease will sooner or later become obvious. But muscle lesions will be missed completely if not thought of, because they never declare their presence by disablement or death, and there is not even an abnormal radiogram to suggest a diagnosis.

Twenty-four cases have been collected by the authors in which an affection of the back caused pain in the front of the abdomen and chest and led to an erroneous diagnosis of visceral disease.

The mechanism of this false localization is discussed in relation to recent work on deep pain sensation.

The lesions are shown to have been in muscles, and it is suggested that they were similar to "rheumatic" affections.

Treatment is effective enough to make it an essential part of the diagnosis; it consists of infiltrating the lesions with procaine, supplemented by massage and exercises.

The pain and its usual variations and associated phenomena are described, and it is held that the syndrome is sufficiently characteristic to suggest a correct diagnosis. This can be confirmed by discovering the muscle lesion responsible.

Variation of Blood Pressure with Brief Voluntary Muscular Contractions

Edmund Jacobson, M.D. In J. Lab. and Clin. Med., 25:10:1029, July 1940.

Experiments are conducted on 11 subjects with normal blood pressure and on 4 with chronically high blood pressure, all of whom

relax at least fairly well upon request, whether through special training or otherwise. Electrical measurements are taken of contraction (action potentials) in various muscle groups, while blood pressure is recorded at certain times from the left upper arm.

Under the conditions of the experiment, it is evident that emotional factors are reduced to a minimum or absent altogether. At the very least it seems safe to say that no more emotion is present when the subject clenches his fist or stiffens his legs than when he tries to relax. Evidently, therefore, emotional variations do not account for the variations in pressure which correspond with variations in skeletal muscle contraction. The indications are that progressive tension in a muscle group tends to elevate systolic and diastolic pressures, and that this tendency increases if contraction spreads to other groups. Accordingly, the present findings lend further support to the view that in individuals with normal, as well as with increased, pressure (essential hypertension), the pressure levels at any instant vary to an important and determinable extent with the magnitudes of contraction in the various skeletal muscles.

The Prevention of Arthritic Deformities by Early Orthopedic Management

John P. Stump, M.D. In Annals of Int. Med., 14:1:87, July 1940.

For the patient who has recovered from the acute stage of arthritis, one must think of preparing his muscles to do the added work required by weight-bearing when he becomes ambulatory. Massage of the back and of the muscles above and below the joints is of primary importance in the development of muscle tissue and muscle tone. Massage at first should be very gentle and should be controlled by the patient's reaction of pain and fatigue. The massage should be given by a well-trained technician under the direct supervision of the attending physician. Active motion, either under water or with the patient in bed, has the double benefit of increasing mobility and muscle development. Passive motion is a form of manipulation and should be used only in special cases. When the patient first starts to walk, it is essential that he have proper footwear to maintain the correct alinement of his lower extremities as well as an adequate brace to control any joint that is not yet capable of self-support. If a brace is required for the back, it must be at least long enough to control the pelvis and the lumbar and low dorsal spine.

When the patient is beginning to bear weight there is a great tendency for body distortions to develop and he will have to be carefully guarded to see that at this stage a deformity of one or more joints does not develop. Any indication of impending deformity should be given immediate attention and treated as in the acute stage of the disease.

Conclusions

The average deformity in the average arthritic can be prevented by the institution of orthopedic management in the early stage of the disease. Cooperation between the internist and the orthopedist, who are primarily responsible for the care of these patients, is needed to insure concurrent orthopedic and medical care from the time the diagnosis is made.

Orthopedic management is based upon a thorough understanding of the nature and development of deformities in chronic arthritis. It requires a knowledge of basic orthopedic principles.

Facial Paralysis and Its Operative Treatment

Josephine Collier, B.M. In Lancet, No. 6100, p. 91, July 27, 1940.

The factors to be considered in every case of postoperative facial paralysis are the time of onset of the palsy, the electrical reactions of the facial muscles, and the condition of the middle ear. Appearance of paralysis immediately after operation indicates complete interference with the continuity of the nerve and calls for operation as soon as the general condition of the patient permits. The shorter the time of facial muscles are denervated, the more perfect will be the results, with minimal tendency to mass movements and contractures.

During the postoperative period the facial muscles must be supported by internal or by external splinting to prevent overstretching. The nutrition of the muscles is maintained by physical therapy, particularly heat. Massage must be directed to prevent elongation of the muscles. As soon as there is minimal return of active movement, careful reeducation before a mirror, with relaxation of the sound side of the face, is the best safeguard against the development of associated movements. Here the cooperation of patient and masseuse is most important. Movements and not muscles are represented in the cortex, and voluntary control of movements can be learned. I think that the training of individual move-

ments is facilitated by avoiding the ordinary galvanic current, which can only stimulate isolated muscles and favors the development of tics and contractures.

Tuberculosis of the Spine: Treatment and Results

Henry W. Meyerding, M.D. In J. Bone and J. Surg., XXII:3:840, July 1940.

Operation to produce surgical fusion of the spine is a comparatively safe procedure. It may be performed without danger of aggravating the disease process. It aids in giving stability to the diseased portion of the spine. It does not necessarily prevent extension of the disease, formation of abscess, irritation of the spinal cord, or paraplegia among patients whose resistance is not good. It is best to delay spine fusion for children who are sick; then, when the process becomes quiescent, spine fusion can be employed as an internal splint to aid in ankylosis. The results of spine fusion as a treatment for tuberculosis of the spine are probably better in adults than in children. An operation that produces fusion of the entire region of involvement gives better immobilization and, consequently, better results than does one that effects fusion of a more limited region. It is often impossible, in the early stages of tuberculosis of the spine, to determine the exact extent of the process either by clinical or by roentgenographic examination.

The best results are obtained when patients are carefully selected for operation, when spine fusion is employed during the period of healing of the disease, and when such treatment is reinforced by conservative treatment for a prolonged period of time.

The paramount requirement for every patient who has tuberculosis of the spine is rest, heliotherapy, and a nutritious diet. No surgical treatment can offset the value of conservative treatment.

A Critical Study of Tuberculosis of the Spine in Children

Leo Mayer, M.D. In J. Bone and J. Surg., XXII:3:875, July 1940.

Despite the great advance of medical knowledge, the essentials in the general treatment of tuberculosis of the spine remain today the same as in the time of Hippocrates—fresh air and sunlight, nutritious food and adequate rest.

A case of tuberculosis of the spine cannot be declared cured because of the disappearance of muscle spasm, tenderness, and pain. It is reasonable to assume a cure under the following conditions:

a. Disappearance of abscesses or their calcification, as seen in the roentgenogram;

b. Block formation of two or more bodies;

c. Closure of sinuses;

d. Absence of pain, temperature, and muscle spasm;

e. Consistent gain in weight.

Short Wave Diathermy

Frank H. Krusen, M.D. In Military Surg., 87:2:158, August 1940.

Contraindications to the Employment of Short Wave Diathermy

Short wave diathermy should not be employed in the treatment of any condition in which there is danger of hemorrhage. Because of the danger of burns, the application of short wave diathermy also is contraindicated over regions in which sensation is impaired. It should not be administered to the abdomen, lower portion of the back or pelvis during pregnancy or during the menstrual period. Also it should not be applied over regions in which there may be a malignant growth or tuberculous lesion. Some authors believe that diathermy should not be applied in the presence of phlebitis because of the danger of embolism.

Summary

It is wise to employ only such diathermy apparatus as has been accepted by the Council on Physical Therapy of the American Medical Association. The various diathermy machines which have been considered acceptable, their efficiency and approved technics for their use are listed in a booklet entitled "Apparatus Accepted by the Council on Physical Therapy of the American Medical Association." Every effort should be made to avoid the use of diathermy except when it definitely is indicated. Certainly there are enough rational indications for its employment to warrant its frequent use. One should not forget, however, that simpler methods of applying heat may be equally effective for the treatment of superficial lesions. Short wave diathermy finds its greatest usefulness for treatment of deeper lesions. It is unquestionably the most valuable form of electrotherapy available today. When employed in a rational manner, it may be used for a multitude of purposes, both in medicine and in surgery.

Book Reviews

PHYSICAL TREATMENT BY MOVEMENT, MANIPULATION AND MASSAGE. By James B. Mennell, M.A., M.D., B.C. (Cantab.), Consulting Physicotherapist, St. Thomas' Hospital, and Lecturer, Massage Training School, London. Fourth edition. Cloth. Price, $7.00. Pp. 669, with 281 illustrations. Philadelphia: The Blakiston Company, 1940.

This is the fourth edition of a book that has been the best treatise on massage ever since its first edition in 1917. The book was written with two main objects in view: First, to point out to physical therapy technicians the rationale of massage and to emphasize the importance of a thorough knowledge of fundamental subjects because Mennell believes that a physical therapy technician should be able to give a definite reason for her selection of each massage movement which is used in treatment. Second, to make the medical profession sufficiently well acquainted with the use of massage that they may give adequate and intelligent prescription of physical therapy treatment. Mennell is noted for his description and use of superficial stroking massage and for his treatment of recent injuries by mobilization and massage. He states that care and gentleness in treatment are very important factors if successful results are to be speedily obtained.

This edition, which has been thoroughly revised, contains chapters on the treatment of recent fractures of the upper and lower extremities, the treatment of recent injuries—sprains, dislocations, torn muscles and bruises; the treatment of after-effects of injury; forced movement—"bone setting;" reeducation of muscle; reeducation in walking; backache; massage as a remedy in the treatment of the wounded and reeducation of amputation cases.

This volume is used as a textbook in many of the schools for physical therapy technicians. It should be in the library of every physical therapist, and it should be read by every surgeon who treats traumatic surgical cases.

MANUAL OF PERIPHERAL VASCULAR DISORDERS. By David W. Kramer, M.D., F.A.C.P., Assistant Professor of Medicine, Jefferson Medical College; Chief Clinical Assistant of Vascular Clinic, Jefferson Hospital, and Consultant on Peripheral Vascular Disorders, Philadelphia General Hospital. Cloth. Price, $6.00. Pp. 448, with 126 illustrations. Philadelphia: The Blakiston Company, 1940.

This monograph on peripheral vascular diseases is divided into four parts. Part one considers the symptoms, methods of studying the peripheral circulation, the evaluation and clinical application of the various circulatory function tests. The second part discusses the occlusive vascular disorders; part three describes the vasospastic and vasodilator disorders, and part four gives a comprehensive discussion of gangrene and disorders of the veins.

Under the consideration of the treatment of thrombo-angiitis obliterans there is an excellent evaluation of the physical agents used in the management of vascular disorders. The author emphasized only those which he has found to be of definite benefit in the treatment of peripheral vascular diseases. This section should be read by physical therapy technicians who are treating these conditions. The monograph can be recommended as a practical manual on vascular disorders.

YOUR LIFE IS THEIR TOY: RACKETS—SOCIAL SERVICE AND MEDICAL. By Emanuel M. Josephson, M.D., Fellow, American Association for the Advancement of Science; American Academy of Ophthalmology and Otolaryngology, etc. Cloth. Price, $3.50. Pp. 449, with portrait. New York: Chedney Press, 1940.

This book censures social service and organized medicine. The author even condemns the two societies of which he believes it such an honor to be a member that he mentions them after his name on the title page. He states that the American Association for the Advancement of Science "became prostituted to the racketeering and politics of the American Medical Association." The purpose of the American Academy of Ophthalmology and Otolaryngology is "above all else to secure for themselves publicity build-ups in the lay press."

David Hume in the Eighteenth Century said: "It is well known that in all questions submitted to the understanding, prejudice is destructive of sound judgment and perverts all operations of the intellectual faculties. It is no less contrary to good taste." The author felt that his wholesale condemnation of the American Medical Association, the American College of Surgeons and numerous other societies would be suspected of prejudice. He says in his foreword: "But I say truthfully and sincerely that my motive is not malice." This statement of the author is interesting in view

of many in the text, such as the following: "About that time I discovered the cause and remedy of primary glaucoma, one of the most frequent causes of hopeless blinding of adults. . . . It eliminates largely the blinding glaucoma operations from which many of the leaders of ophthalmology derive a large part of their incomes. They therefore undertook to suppress my sight-saving discovery." Elsewhere he states that a report of successful treatment with vitamin E of a series of cases of a group of diseases including myasthenia gravis and progressive muscular dystrophy, which he presented before an optometric society, was rejected by medical journals for the usual reasons of medical politics.

Considering the volume generally we are again reminded that "prejudice is destructive of sound judgment."

MODERN MEDICAL THERAPY IN GENERAL PRACTICE. Edited by David Preswick Barr, A.B., M.D., LL.D., Busch Professor of Medicine, Washington University, Physician in Chief, Barnes Hospital, St. Louis. Three Volumes. Cloth. Price, $35.00. *Pp.* 3661, *with illustrations. Baltimore: Williams and Wilkins,* 1940.

These volumes form a complete systematic work on the treatment of disease. Volume one discusses general therapy, methods used in therapy and general disease. Infectious diseases, diseases of the nervous system and the digestive system are considered in volume two. Volume three deals with the diseases of other organs and systems. Each volume has an index and there is a general index in volume three for the entire system.

The volumes have a distinguished list of contributors presenting the therapy as used in more than fifty hospitals and in teaching in many medical schools. Therefore, there is available in this system a modern consideration of many forms of treatment by outstanding specialists in the various fields. There are many illustrations and good bibliographies.

There is a section in the first volume devoted to physical therapy. There are chapters on the use of heat and cold by Ewerhardt; hydrotherapy and balneotherapy by McClellan; medical diathermy by Coulter; other forms of electrotherapy by Coulter; artificial fever therapy by Simpson; light therapy by Krusen; radiotherapy with x-rays and radium by Arneson, and corrective exercise by Ewerhardt. There also are chapters on therapeutic aspects of climate and weather effects by Mills, and occupational therapy by Dunton.

ILLUSTRATION: ITS TECHNIQUE AND APPLICATION TO THE SCIENCES. By Carl D. Clarke, M.A., Associate Professor of Art as Applied to Medicine, University of Maryland, Baltimore. Cloth. Price, $5.50. *Pp.* 394, *with* 272 *illustrations. Baltimore: The John D. Lucas Company, Publishers,* 1939.

Medical authors usually are desirous of having their articles illustrated in the best possible manner. This volume presents some idea as to the kinds of pictures to use for particular purposes and the sources from which they may be obtained.

The first two chapters are devoted to a history of medical drawing and painting and a short history of the outstanding anatomical illustrators from the beginning of the early renaissance to the present time. There are sixteen chapters on the technic and art of drawing, and chapters on pathological, surgical and chemical drawings, wash drawings, lettering, color work, chart making, microscopic subjects and photography.

The illustrations are excellent. This volume can be highly recommended to authors of scientific papers as a reference work and as a textbook for beginners in the art of illustration for the sciences.

THE REHABILITATION OF SPEECH: A TEXTBOOK OF DIAGNOSTIC AND CORRECTIVE PROCEDURES. By Robert West, Ph.D., Professor of Speech Pathology, University of Wisconsin, Lou Kennedy, Ph.D., Associate Professor of Speech, Brooklyn College, New York, and Anna Carr, M.A., Clinical Adviser in Speech, State Teachers College, Milwaukee, Wisconsin. Cloth. Price, $4.00. *Pp.* 475, *with* 28 *illustrations. New York & London: Harper & Brothers,* 1937.

This is an excellent textbook for students and professional workers engaged in the practice of speech rehabilitation. Part I deals with diagnostic procedures in which there are discussions of the neurophysiological mechanisms of speech and the signs and symptoms of both functional and organic speech disorders. Part II deals with remedial procedures in which specific exercises for retraining are presented. The remaining parts of the book deal with specific problems of speech, such as a foreign language influence, etc., and the book concludes with a very instructive section of case histories, tests and tables, and a much-desired glossary.

Those interested in the problems of speech will find this volume indispensable.

LOVE PROBLEMS OF ADOLESCENCE. By Oliver M. Butterfield, Ph.D. Cloth. Price, $2.25. Pp. 212. New York: Emerson Books, Inc., 1939.

By the questionnaire method the author has obtained records from over a thousand young people in whose lives the problems relating to love and marriage naturally arise. The relative frequency of specific problems occurring in boy and girl relationships was of special interest, and the significance of these common problems in the moral, social and religious concepts and experiences was analyzed. Petting, kissing, engagements, extramarital sex relations and birth control were found to be the most frequent concerns of the adolescents.

The study emphasizes the need for honest, straight-forward education of our young people if we wish to achieve wholesome, healthy adjustments in love and marriage.

GETTING MORE OUT OF LIFE. By Joseph Jastrow, Ph.D., LL.D., Formerly Fellow in Psychology, Johns Hopkins University; Professor of Psychology, University of Wisconsin; President of the American Psychological Association; of the Staff of Columbia University; of the Staff of the New School for Social Research. Revised Edition. Cloth. Price, $2.00. Pp. 312. New York: Emerson Books, Inc., 1940.

The author states that the purpose of this book is to guide you in your aid to live at the top level of your capacities and your opportunities. He proves that the program of getting more out of life is not a magic formula. He deals with the question of living sensibly under five heads: accepting our endowments; employing our resources; regulating our beliefs; handling out liabilities, and patterning our expressions.

It is shown that sensible living is not a matter of book learning but that it takes sense to benefit by experience. What experience one chooses also is an issue of sense. The author believes that self knowledge remains one of the indispensables to high grade sensible living. For a happy and effective life, he rates highest, sensible social living in your human relations.

Beginning with the simplest, the steps to the most complex phases of safe and sane living are discussed. Tolerance is shown to be indispensable to the sensible life.

Living sensibly is most important to every physical therapy technician because she daily has to teach her patients this art and to reeducate the patient's habits that interfere with sensible living. A physical therapist must know how to live herself before she can help the psychological ills of her patients. This often makes the difference between success and failure in treatment. The volume is highly recommended.

PHYSICAL THERAPY FOR NURSES. By Richard Kovacs, M.D., Clinical Professor and Director of Physical Therapy, New York Polyclinic Medical School and Hospital; Attending Physical Therapist, Manhattan State, Harlem Valley State and West Side Hospitals; Visiting Physical Therapist, New York City Department of Correction Hospitals; Consulting Physical Therapist, New York Infirmary for Women and Children; Mary Immaculate Hospital, Jamaica, New York, Hackensack Hospital, Hackensack, New Jersey. Second edition. Cloth. Price, $3.25. Pp. 335, with 99 illustrations. Philadelphia: Lea & Febiger, 1940.

Courses in physical therapy are now given in many training schools for nurses. The author presents concisely, in this volume, the subject of physical therapy, exclusive of x-rays and radium, for use as a manual of instruction in nurses' training curricula.

There are seven parts and an appendix. Part one is an introduction; part two deals with the physics, physiological effects and clinical uses of heat and artificial fever; part three discusses the physics, effects and therapeutic uses of natural and artificial ultraviolet radiation; part four considers electrophysics, general electrotherapy, the galvanic current, low frequency currents, electrodiagnosis, long wave diathermy, short wave diathermy and static electricity; part five contains chapters on the physical and physiological principles of hydrotherapy, hydrothermal measures, hydrokinetic measures and colonic irrigation; part six is on massage and part seven by Dr. Madge C. L. McGuinness gives the physiology of exercise, general and special exercises and occupational therapy. The appendix gives a short discussion on physical therapy in institutional practice.

In this second edition the subject matter has been extensively revised. The chapters on the history of physical therapy, on short wave diathermy and on colonic irrigation are new. Forty-seven new illustrations have been added. This volume is highly recommended to nurses and to nurses' training schools.

SPEECH CORRECTION: PRINCIPLES AND METHODS. By C. Van Riper, Ph.D., Director of the Speech Clinic, Western State Teachers College. Cloth. Price, $2.50. *Pp.* 434, *with* 25 *illustrations. New York: Prentice-Hall, Inc.,* 1939.

The importance of speech in everyday life is made evident particularly by those cases of individuals handicapped in this function. The author of "Speech Correction" emphasizes the psychologic aspects of such an "organ inferiority" as well as the problems related to the mechanics of speech disorders. In clear, concise chapters he discusses the nature of speech, the development of speech, the difference between functional and organic speech disorders, special tests and examination methods, and treatment. The author calls to attention the fact that speech correction is a relatively young profession. As an introduction to this subject, this book may be highly recommended.

AN INTRODUCTION TO MEDICAL SCIENCE. By William Boyd, M.D., M.R.C.P. (Edin.), F.R.C.P. (Lond.), Dipl. Psych., F.R.S. (Canada), Professor of Pathology in the University of Manitoba; Pathologist to the Winnipeg General Hospital, Winnipeg, Canada. Cloth. Price, $3.50. *Pp.* 307, *with* 108 *illustrations. Philadelphia: Lea & Febiger,* 1939.

This book offers an aeroplane view of disease. The author believes that an understanding of diseases does not consist of learning a vast number of scientific names but rather to comprehend the process which is going on within the body. Technical terms, therefore, have been reduced to a minimum and emphasis laid on the disease process itself.

The first section of the book deals with the general principles of disease, the second with the diseased organs, and the third with some practical applications. The author continually points out the close relationship that exists between the pathological changes or lesions in the organs and the symptoms from which the patient suffers.

The third section of the book is devoted to two important phases. In one chapter on prevention of disease attention is focused mainly on infectious disease and an attempt is made to show by what different means the spread of infection can be prevented. The last chapter on "The Nurse and the Laboratory" shows that the success of a laboratory examination depends to a considerable degree on the care and accuracy with which the material is collected and handled by the nurse. It also endeavors to give her some understanding of and interest in the reports which are returned from the laboratory to the ward.

This volume can be recommended to the nurse, the x-ray and physical therapy technician. It will be of value to them in bringing about a clearer comprehension of medical science and a closer cooperation with the physician.

MEN AGAINST MADNESS. By Lowell S. Selling, M.D., Ph.D. Cloth. Price, $3.50. *Pp.* 342, *with* 42 *illustrations. New York: Greenberg, Publisher,* 1940.

The high incidence of mental illness in this country as well as others bears witness to the importance of the subject of psychiatry. Although this branch of medicine has received recognition only comparatively recently as a special branch of medical science, the history of mental disorders dates back to the early centuries. "Men Against Madness" is a record of the origin and growth of this subject. In contrast to other histories of psychiatry this presentation tells the story in a much lighter and more entertaining vein. For the layman this type of education has become more and more popular. The book is easy to read and its facts are presented with a view toward entertainment as well as enlightenment. Although this book can scarcely be rated as a good scientific presentation of the history of mental disorders, students, nurses and physicians in general will find this book pleasurable reading.

A DOCTOR'S HOLIDAY IN IRAN. By Rosalie Slaughter Morton, M.D. Foreword by Surgeon-General Hugh S. Cumming (Retired). Cloth. Price, $3.00. *Pp.* 335, *with* 20 *illustrations. New York & London: Funk & Wagnalls Company,* 1940.

This is an interesting book by a famous woman physician. Doctor Morton was the first woman to hold a professorship in the Medical School of Columbia University. As a commissioner of the American Red Cross she went to France and to Serbia before the United States entered the first World War. She served as a surgeon on hospital boats in the Mediterranean and worked under fire through four epidemics. Doctor Morton founded the American Women's Hospital. She was decorated nine times for distinguished service at the front. Her book, "A Woman Surgeon," has gone into many editions.

In March 1935 the Shah decreed that Persia

should be known as Iran. The story starts with Doctor Morton's automobile ride from Bagdad, Iraq, to Teheran, Iran, over the desert with the thermometer registering 122 degrees Fahrenheit. The driver insisted on closing all the windows "to keep out the mountain demons," as he drove over desert and mountain passes. In writing of this journey the author gives an excellent description of travel in Iran. Following this Doctor Morton gives a sympathetic picture of the people, the nomads, the villagers, the city dwellers as they adjust themselves to shaking free of the shackles of the past.

The present Shah, Riza Pahlavi, is of especial interest to Americans because he, like Lincoln and many others in America, has risen through sheer ability from poverty to become a great leader. The Shah is determined to have his country modern and scientific, and Doctor Morton gives an astute summary of the development of the country under its great ruler.

This volume can be recommended as giving a well rounded picture of a country which is as old as time but is now looking to the future with hope and confidence. The illustrations are excellent.

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